TECHNICAL EVALUATION OF THE GREENHOUSE GAS EMISSIONS REDUCTION QUANTIFICATION FOR THE FRESNO COUNCIL OF GOVERNMENTS' SB 375 SUSTAINABLE COMMUNITIES STRATEGY

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California Environmental Protection Agency
Air Resources Board

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Executive Summary

The Sustainable Communities and Climate Protection Act of 2008 (Senate Bill 375) is intended to support the State's broader climate goals by encouraging integrated regional transportation and land use planning that reduces greenhouse gas (GHG) emissions from passenger vehicle use. Now in its sixth year of implementation, SB 375 has resulted in several regional Sustainable Communities Strategies (SCS) which are developed as part of the Regional Transportation Plan (RTP). These SCSs demonstrate whether, if implemented, the metropolitan planning organizations (MPOs) of California can meet the per capita passenger vehicle-related GHG emissions targets for 2020 and 2035 set by the California Air Resources Board (ARB or Board) in 2010.

For the Fresno Council of Governments (COG), the MPO for the County of Fresno, the Board set passenger vehicle GHG emissions reduction targets of five percent per capita reduction in 2020 and ten percent reduction in 2035 from a base year of 2005. The RTP/SCS adopted by the Fresno COG Board on June 26, 2014 states that, if implemented, the RTP/SCS would meet the GHG reduction targets. Fresno COG transmitted the adopted SCS to ARB for review on December 2, 2014. The ARB staff evaluation presented in this report affirms that Fresno COG's adopted 2014 SCS would, if implemented, meet the Board-adopted per capita GHG emissions reduction targets of five percent in 2020 and 10 percent in 2035.

Fresno County, home to over 950,000 people, is the most populous county in the San Joaquin Valley. The largest city, Fresno, is the fifth largest city in the State of California. Most of the land in Fresno County is either agriculture or open space. Fresno County is the top agricultural county in the nation with annual production valued at $6.6 billion in 2012, and the agricultural industry is a significant employer and driver of the County's economy. Except for Fresno and Clovis, the 15 cities in Fresno County have populations under 25,000. The urban development pattern in Fresno County over the last thirty years has been characterized by low density housing and suburban style commercial development with dispersed job centers.

Implementation of the 2014 RTP/SCS would change the region's historical land use pattern and transportation investments through 2040. The plan assumes that local jurisdictions will maintain their historic rates of growth, but the growth would occur within existing urban service boundaries to encourage infill and minimize leapfrog development. Further, over 75 percent of the region's population growth through 2035 is forecast to occur within the Fresno-Clovis Metro area, based on recently updated general plans for Fresno and Clovis which include policies to accommodate a larger share of growth with infill development.

Paired with this inward focused development are increased transit and active transportation investments. This includes funding for five bus rapid transit lines in the city of Fresno and over 500 new lanes miles of bicycle facilities countywide. These strategies would increase the proximity of residents to transit and biking and walking facilities, leading to greater use of active modes of transportation. The 2014 RTP/SCS also includes transportation system management and transportation demand management measures (for example, carpooling, vanpooling, and ramp metering) to reduce trips and increase system efficiency.

As a result of the strategies, the 2014 RTP/SCS is projected to result in significantly different land use and transportation outcomes compared to the prior 2011 RTP. The 2014 RTP/SCS would increase the average density of new residential development from 4.9 dwelling units per acre to 9.3 units per acre. This is due in part to the increased proportion of multi-family residential units from 22 percent to 47 percent of total new housing by 2035. This denser development also reduces the total amount of land consumed by development, leading to conversion of 38 percent less important agricultural land than the prior RTP. In aggregate, the SCS strategy to place new housing units closer to destinations is projected to achieve a 9.6 percent per capita reduction in vehicle miles traveled by 2035.

SB 375 directs the Board to accept or reject the determination of each MPO that the Sustainable Communities Strategy (SCS) would, if implemented, achieve the GHG emissions reduction targets for 2020 and 2035. This report reflects ARB staff's technical analysis of the Fresno COG RTP/SCS and describes the methods used to evaluate its GHG quantification.

ARB staff's technical analysis was enhanced by being able to run Fresno COG's travel model which was provided by the MPO. Based on a review of the four central components of Fresno COG's quantification methodology and supporting analyses, ARB staff found the methodology and the emissions quantification to be reasonable. Data inputs and assumptions and modeling tools are reasonable but can be improved, as noted in the analysis. Model sensitivity tests showed that the model is reasonably responsive to changes in key inputs and the SCS performance indicators support the modeled change in GHG emissions. Throughout this report are several suggestions for Fresno COG to implement in its next model improvement plan. If implemented, these suggestions should improve the regional model's ability to capture the GHG benefits of the land use and transportation strategies contained in future SCSs.

I. Fresno Council of Governments

The Fresno Council of Governments (Fresno COG) serves as both the Regional Transportation Planning Agency (RTPA) and the federally designated Metropolitan Planning Organization (MPO) for Fresno County and is responsible for long range transportation planning in the County of Fresno. Like the rest of the MPOs in the San Joaquin region, Fresno COG represents a single county. Fresno COG's Board is composed of representatives from 15 cities—Clovis, Coalinga, Firebaugh, Fowler, Fresno, Huron, Kerman, Kingsburg, Mendota, Orange Cove, Parlier, Reedley, San Joaquin, Sanger and Selma—and Fresno County. These representatives coordinate with technical advisory committees, citizens, stakeholder groups and other government agencies to develop and update regional transportation plans (RTP)[1] every four years. The Regional Transportation Plan 2040, adopted on June 26, 2014, is the eighteenth edition since the first RTP was adopted in 1975 and the first to include a Sustainable Communities Strategy (SCS)[2].

A. Planning Area

Figure 1: Fresno County Context Map

[1] An RTP is a federally required plan to finance and program regional transportation infrastructure projects, and associated operation and maintenance for the next 20 years.

[2] The SCS sets forth a forecasted development pattern for the region which, when integrated with the transportation network and other transportation measures and policies, will reduce the greenhouse gas emissions from automobiles and light trucks. It shall include identification of the location of uses, residential densities and building densities, information regarding resource areas and farmland.

San Joaquin Valley Context

Fresno County is located in central California and is part of the San Joaquin Valley (SJV or Valley).The Valley is characterized by agricultural communities and small urban areas predominantly located near the State Route (SR) 99 corridor, which runs north-south in the center of the region. There is heavy truck travel along the Interstate 5 (I-5) corridor, which runs along the western edge of the Valley and serves as the backbone for goods movement throughout the State.

Fresno County has the largest population of the eight counties in the San Joaquin Valley with 952,200 people.

Fresno County is the most populous of the eight counties that make up the San Joaquin Valley in central California. These eight counties (Kern, Kings, San Joaquin, Merced, Madera, Stanislaus and Tulare and Fresno) account for over 11 percent of the population of California and collectively are more populous than 24 of the 50 states nationwide. The Valley continues to grow and is expected to account for 15 percent of California's population by 2050.

The residents of the San Joaquin Valley face challenges of poor air quality, high unemployment, and low average incomes. Most of the jobs across the eight county San Joaquin Valley are in agriculture (12 percent), education, health and social services (21.5 percent), or retail trade (11.3 percent). The unemployment rate across the Valley counties is 15 percent average, which is higher than the 11 percent State average. Educational levels for Valley residents lag behind California with only 24 percent of persons 25 years of age and older having a college degree, compared to 39 percent statewide. Related to these unemployment and education factors, the Valley's median household income of $45,000 is far below the State average of $58,000.

Fresno County

Fresno County ranks as the top agricultural county in the U.S. with annual production valued at $6.6 B in 2012.

Fresno County is surrounded on two sides by mountains—the Coastal Range foothills to the west and the Sierra Nevada foothills to the east. There are a total of 15 cities in the County, in order from most to least populous: Fresno, Clovis, Reedley, Sanger, Selma, Coalinga, Parlier, Kerman, Kingsburg, Mendota, Orange Cove, Huron, Firebaugh, Fowler and San Joaquin. Most of the County's population is located in the central portion of the county, along the (SR) 99 corridor. Several smaller foothill communities and large amounts of National Forest and Park Service land are located in the eastern portion of the County. Productive agricultural land constitutes most of the western and central portion of the County and has made Fresno County the number one agricultural county in the United States, with annual production valued at $6.6 billion in 2012 (2014 RTP/SCS). This agricultural industry accounts for almost 14 percent of jobs in Fresno County (compared to less than three percent statewide), with even more jobs associated with the transport and manufacturing of agricultural products. Other major employment sectors include education, health and social services (22 percent) and retail (10 percent). Like the greater San Joaquin Valley, education and income levels trail behind California averages.

B. Current Land Use

Most of Fresno County's approximately 3.8 million acres of land is either agriculture or public land (National Forest and Park Service). Agriculture accounts for nearly half of the County's land area with approximately 1.5 million acres under Williamson Act preserve status as of 2011, meaning that landowners receive property tax relief to refrain from developing the land.

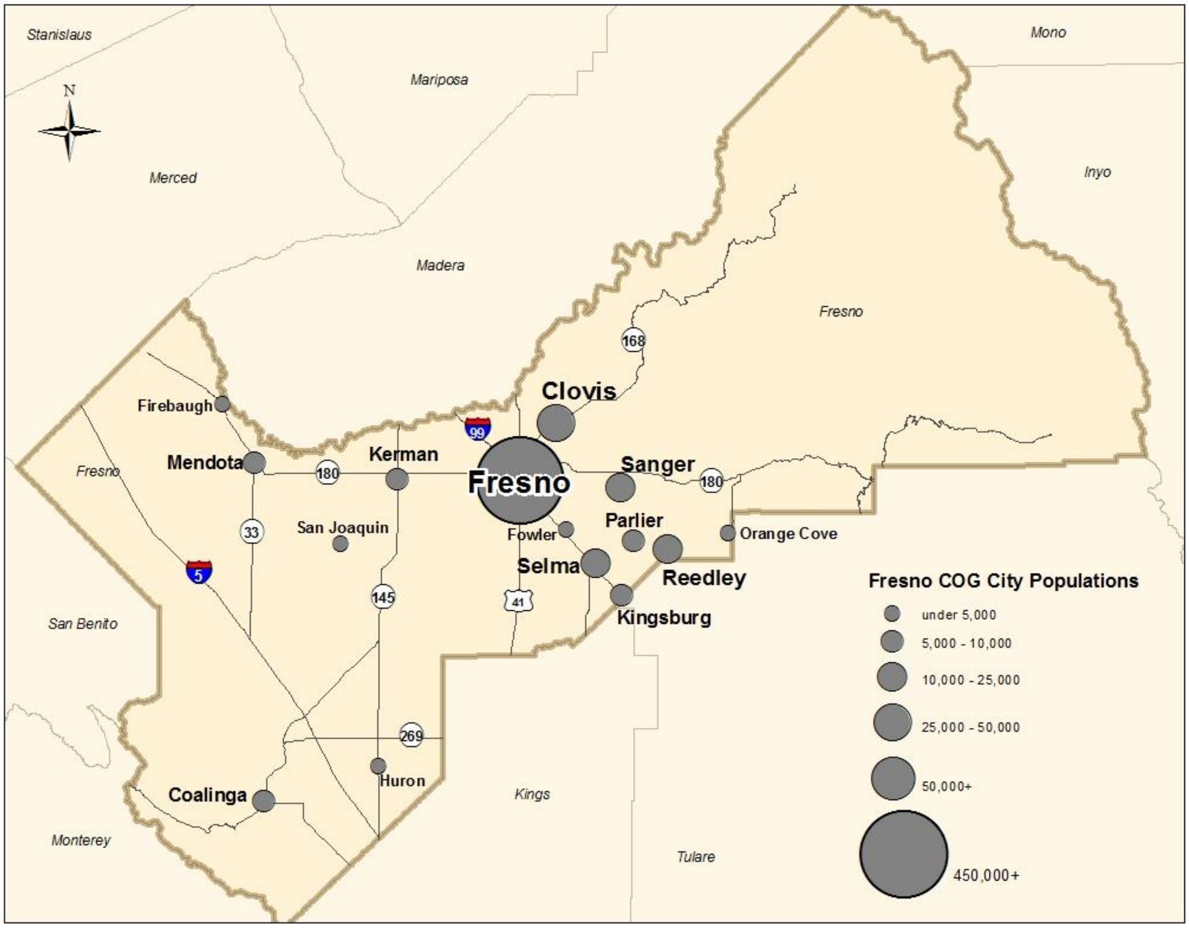
The Fresno-Clovis Metro Area houses 64 percent of the county population. Twenty percent of the county population lives in the other 13 cities.

The majority of Fresno County's 952,200 residents live in the Fresno-Clovis Metropolitan Area (FCMA) with 53 percent of the county population residing in the City of Fresno and nearly 11 percent residing in the City of Clovis. The City of Fresno is the fifth largest city in California and the major population center in the San Joaquin Valley. Smaller cities, both along SR 99 and throughout the county, range in population between 4,000 and 25,000 residents and account for nearly 20 percent of the county population. The remaining 18 percent of the population lives in unincorporated County areas such as farming communities throughout the County and in the foothills east of the City of Fresno.

Many of the smaller cities in the County—like Reedley, Selma and Kingsburg—emerged as farming communities and Southern Pacific railroad stops, developing at a pedestrian scale that features a downtown commercial strip and nearby small lot single family residential. These incorporated cities, along with the FCMA encompass most of the urban residential zones, which allow small lots and higher relative density. Moving away from these urban centers, residential parcel sizes tend to become larger.

Much of the growth near the urban centers since the 1970s has consisted of low density commercial, single family detached homes and decentralized employment centers. For example, in the 1970s downtown Fresno was the County's largest job center. Now, multiple employment centers in the county—including north Fresno and Clovis—have as many or more jobs as downtown. Despite the low density character of recent development, urbanized areas still constitute a small percentage of the County's land. The FCMA makes up about 2 percent of the total County acreage.

Figure 2: Population and Development



C. Current Transportation Network

The 3,600 mile Fresno County road system facilitates the movement of residents to destinations within and beyond the county and serves the multi-billion dollar agricultural goods industry. There is a high level of auto dependence due to the low density of development over the last 30 years. Passenger vehicle travel is the predominant mode of transportation, making up about 92 percent of total trips and 95 percent of work trips. Interstate 5 serves a high volume of truck traffic between San Francisco and Los Angeles and other statewide destinations. SR 99 accommodates a large amount of regional passenger and truck travel because of its proximity to major population centers in the San Joaquin Valley. The county's road network provides access between Fresno County cities and connects regionally significant destinations such as the California State University Fresno and the SR 41 corridor to Yosemite National Park.

Transit

The cities of Fresno and Clovis are served by fixed route bus transit (Fresno Area Express and Stageline) and smaller cities and rural areas are served by a limited bus service operated by the Fresno County Rural Transit Agency (FCRTA). Despite the high percentage of single occupant vehicle travel, demand for and ridership of Fresno County's transit services is increasing. Transit ridership represents 1.6 percent of all passenger vehicle trips in the region with the greatest transit use occurring in the two largest cities, Fresno and Clovis. This transit ridership rate is slightly above SACOG's 1.3 percent ridership rate and slightly below SANDAG's and SCAG's ridership rates of 2.4 and 2.34 percent, respectively.

Fresno Area Express (FAX) is the major public transportation agency in City of Fresno operating both a high capacity, high frequency fixed-route service and a demand responsive service for impaired or disabled riders. Illustrative of the increasing demand for transit, from 2003-2012 transit ridership on FAX rose over 21 percent despite a 3.7 percent decrease in service miles. In Clovis, the Stageline offers four fixed routes with 30 minute headways, limited weekend fixed-route service, and a demand-responsive paratransit service (RoundUP). In smaller cities and rural communities, FCRTA provides limited fixed-route service, demand responsive services between communities, and links to the Fresno-Clovis Metro area through several transit subsystems.

Transportation options to destinations outside of Fresno County include Amtrak, Greyhound, and Transportes Intercalifornias. Amtrak and Greyhound provide daily service out of Fresno to many destinations throughout California including Bakersfield, San Jose, and Sacramento. Transportes Intercalifornias, a private bus company with service to Mexico, provides three daily trips to Los Angeles.

Biking

Bicycle travel is possible nearly year-round in Fresno County because of the relatively flat terrain and semi-arid climate. The 134 mile bicycle network in the City of Fresno connects destinations within Fresno and to the 55 miles of bikeways in Clovis. Many other cities throughout the county have recently addressed bicycle transportation in their general plan circulation elements and with other local planning documents and policies to support a safer and more extensive active transportation network. All but two cities have completed Bicycle Transportation Plans, which allows them to qualify for Bicycle Transportation Account and Measure C Bicycle Facilities Funding. In 2013, the County of Fresno adopted a Regional Bicycle & Recreational Trails Master Plan, which coordinates with existing local bikeway plans to encourage community members to commute to work and school by biking or walking instead of driving.

II. Fresno COG Sustainable Communities Strategy

Development of the 2014 SCS began in 2012 and was built on Fresno COG's earlier efforts to establish more sustainable planning policies through the San Joaquin Valley Blueprint. The planning and development process involved taking account of the current land use and regulatory environment of the county, gathering public and stakeholder input on the desired future development, and creating alternative growth scenarios to illustrate options for the future of Fresno County through 2040.

A. Policy Setting

Urban Boundary Agreements: In 1983, the cities of Fresno and Clovis and the County of Fresno negotiated the Joint Resolution on Metropolitan Planning, which defined their urban boundaries and required that no amendments be made without the agreement of affected parties. This ensures that the spheres of influence[3] cannot be expanded without the concurrence of the other affected local governments. This policy decision and associated sales tax agreements has directed urban growth within the existing city boundaries.

Air Quality Planning: Fresno County is within the jurisdiction of the San Joaquin Valley Air Pollution Control District (Valley Air District). Because of the air basin's non-attainment status for national ambient air quality standards for ozone and particulate matter pursuant to the Clean Air Act, the Valley Air District and Fresno COG coordinate on transportation planning. Fresno COG must demonstrate that the projects recommended in the RTP conform to the emissions budget that would attain the national ambient air quality standards. The analysis demonstrates conformity with all of the set budgets for each applicable pollutant.

Planning for adequate housing. A regional housing needs assessment (RHNA) is a county level housing accommodation target set by the California Department of Housing and Community Development (HCD) to ensure that local governments adequately plan to meet current and future housing needs of the population according to income groups. Fresno COG received RHNA allocations for the (2013-2023) housing element cycle and was engaged in this process concurrently while developing the RTP/SCS. The different projection period cycles of RHNA and the SCS (10 years and 27 years, respectively) prevent direct comparisons, as does the difference in the way that RHNA distributes housing by political jurisdiction whereas the SCS distributes housing by geographic area. Although the RHNA targets had not yet been allocated to specific local governments at the time of adoption of the RTP/SCS, overall the total number of

[3] A physical boundary for the probable future service area of a local government; defines the primary area to accommodate growth.

housing units projected in the SCS is more than sufficient to satisfy the designated RHNA targets for Fresno County.

Regional Blueprint Planning: In 2006, Fresno COG began a voluntary collaboration process with the seven other RTPAs[4] in the Valley to develop the San Joaquin Valley Blueprint (or Valley Blueprint). The purpose of this collaboration was to explore policy solutions to a host of growing concerns that affected the Valley as a whole, including housing needs, job creation, traffic congestion, and air quality. With Proposition 84 funding from the California *Regional Blueprint Planning Program* each RTPA prepared a separate countywide blueprint, which was then consolidated into the single Valley Blueprint. The Valley Blueprint created a long-range vision for the future of the San Joaquin Valley, where more farmland and open space is protected by directing growth into existing communities and offering alternative transportation options. This resource provides technical data to help local decision makers make better-informed land use and natural resource decisions.

The Fresno COG Policy Board endorsed the Fresno Blueprint on May 29, 2008, which then became a component of the San Joaquin Valley Blueprint. The Fresno Blueprint provides a policy foundation for the current SCS by drawing on 12 smart growth principles to guide local jurisdictions in their land use decisions. These principles, in the first column of **Table 1**, address environmental, economic, and social aspects of urban and rural form. In 2010, Fresno COG began work on the implementation component of the Blueprint, which resulted in a toolkit of policies that planners and policymakers in the cities and the county can use for their own local planning. The second column of Table 1 represents ARB staff's assessment of how the smart growth principles are reflected in the 2014 RTP/SCS.

Table 1: Fresno County Blueprint Smart Growth Principles

Blueprint Smart Growth Principle	Reflected in the 2014 RTP/SCS
1. Create a range of housing opportunities and choices	Higher percentage of multifamily units and mixed use residential development
2. Create walkable and bikeable neighborhoods	Increased funding for pedestrian and bicycle amenities
3. Encourage community & stakeholder collaboration	Significant public outreach guided by the public participation plan, held community workshops in multiple cities

[4] The participating RTPAs include: Fresno COG, the Kern Council of Governments (Kern COG), the Kings County Association of Governments (KCAG), the Madera County Transportation Commission (MCTC), the Merced County Association of Governments (MCAG), the San Joaquin Council of Governments (SJCOG), the Stanislaus Council of Governments (Stan COG), and the Tulare County Association of Governments (TCAG).

4. Foster distinctive, attractive communities with a strong sense of place	The City of Fresno's General Plan Update preferred scenario includes Complete Neighborhoods element
5. Make development decisions predictable, fair and cost effective	The transportation project selection process drew on public participation and explored multiple spending plans for flexible funds
6. Mix land uses	Focuses job and housing growth in existing activity centers and corridors, resulting in greater mix of uses
7. Preserve open space, farmland, natural beauty and critical environmental areas	The SCS projects consumption of 14,675 for urbanization compared to 22,308 in the 2011 RTP (a difference of 7,633 acres)
8. Provide a variety of transportation choices	Increases funding for transit and active transportation
9. Strengthen and direct development towards existing communities	Encourages infill development
10. Take advantage of compact building design	Increases multifamily from 15% to 38% of new housing stock
11. Enhance the economic vitality of the region	More compact development reduces the consumption of economically important farmland and reduces the cost to municipalities of infrastructure and service provision
12. Support actions that encourage environmental resource management	Infill development and increased density reduce land consumed by 34 percent and reduces important farmland consumed by 75 percent

Source: FCOG 2014a, SJVCOG 2010

Planning for regional open space and natural resources: The San Joaquin Valley Greenprint project serves as a resource to Valley planners, decision makers, resource managers and the general public by providing data, online mapping tools and analysis to protect and conserve natural resources. Fresno COG manages the Greenprint project on behalf of the Valley MPOs. Greenprint phase 1 was completed in 2014 and resulted in an inventory of parks, open space, critical habitat, floodplains and groundwater recharge zones which were useful in developing Fresno's 2014 RTP/SCS. With additional funding from the Strategic Growth Council (SGC), phase 2 will begin in 2015 and include pilot projects that make use of the inventory, development of a guide on resource management strategies, and creation of an expert panel to discuss methods to address challenges in resource management.

Local general plans: The cities of Fresno and Clovis, representing nearly two thirds of the region's population, have incorporated Blueprint goals for more dense and infill development in their general plans[5]. Clovis adopted its most recent general plan update in August 2014 and Fresno adopted its general plan update in December 2014. The City of Fresno's plan proposes a strategy to accommodate 45 percent of growth in infill development areas. Reedley and Selma are two smaller cities in Fresno County that also recently updated their general plans, in 2014 and 2010, respectively. Their general plan policies included supporting higher density, infill, and mixed use development that provide for pedestrian and bicycle access.

> *City of Fresno's General Plan Update, adopted in 2014, accommodates 45 percent of new growth in infill areas.*

B. 2014 RTP/SCS Development

Steps in the preparation of the SCS included forecasting growth in Fresno County through the 2040 plan horizon, selecting performance measures that reflect desired outcomes of the final plan, ranking transportation investment projects, examining alternative growth scenarios, and choosing a preferred SCS scenario through a public process.

1. Regional Growth Forecast

Demographic and socioeconomic growth forecasts help Fresno County plan for the number of people living, working and travelling in the region for the RTP/SCS timeframe. These forecasts are fundamental to the development of transportation and land use scenarios.

In March of 2012, the Planning Center conducted demographic forecasting for all San Joaquin Valley counties using the least-squares method and data from the California Department of Finance (DOF), which resulted in three primary forecasts for population, households and housing units (Table 2). The three primary forecasts were based on several trend projections including employment, housing unit, and average household size trends using data from DOF, the U.S. Census Bureau, and the California Employment Development Department.

[5] General Plans are comprehensive long-range plans, required for municipalities in California that establish the growth policy direction for the next 20 years.

Table 2: Fresno County Growth Forecasts

Year	Population	Housing Units	Employment
2005	872,569	294,156	335,159
2008	912,521	310,579	345,816
2020	1,082,097	363,142	363,581
2035	1,300,597	434,519	427,727
2040	1,373,679	458,330	449,111

Source: FCOG 2014a

The rate of population growth in the Fresno region is projected to be over 40 percent between 2008 and 2035, close to the projected population growth rate of the Sacramento (SACOG) region and higher than the growth rates of the Bay Area, San Diego, and Southern California regions.

2. Performance Measures

In September of 2012, Fresno COG held the first of six focus group meetings[6] with the public and local stakeholders to select the following performance measures to evaluate the alternative SCS scenarios.

- Criteria pollutant emissions
- Transit oriented development
- Vehicle miles traveled
- Greenhouse gas emission reduction
- Land consumption
- Compact development
- Residential density
- Important Farmland
- Housing by types
- Active transportation and public transit

These performance measures were chosen to reflect the preferred outcomes of an SCS and allow for comparison of SCS scenarios using qualitative and quantitative metrics.

[6] Focus group meeting topics: social equity, health, natural resources, environment, transportation and business.

3. Transportation Project Selection

In January 2013, the 16 member agencies of Fresno COG submitted transportation projects that they expected to complete within the RTP timeframe. The Financial Element Technical Working Group, composed of representatives from local governments with expertise in the areas of engineering, planning, and programming, evaluated the pool of requested projects and developed a ranked project list after scoring the individual projects using a set of criteria specific to the goals for each of the four modes[7] (bike and pedestrian, transit, operations and maintenance road projects, and capacity increasing road projects). This ranked project list was then compared to possible revenue scenarios to develop two separate financially constrained project lists. In March 2013, the Fresno COG Policy Board accepted the project list that was the most inclusive and compatible with available funding which represented a total project cost of approximately $4.5 billion.

4. SCS Scenarios

The growth forecasts, performance measures and constrained transportation project list helped inform the development of alternative planning scenarios. In total, four scenarios were explored.

Scenario A

Scenario A was developed during a public workshop in November 2012 at which community members indicated where they would like to see growth occur. The results were then digitized, analyzed, and converted into Scenario A. The land use strategy was characterized by higher-than-average growth in some rural communities and historically average growth in the Fresno metro area.

This scenario was not chosen in part because it did not reflect the land use patterns in local general plans and placed much higher growth in some rural communities. According to the performance indicator outcomes evaluated by Fresno COG, this Scenario would lead to fewer total acres of land consumed than the preferred scenario (B) but would consume more important farmland acres outside of the spheres of influence.

Scenario B

Scenario B was developed with input from the Fresno COG member agencies- 15 cities and the county- to reflect the existing city and county growth trends and

[7] Scoring criteria included, among other considerations: consistency with current plans and intent of SB 375, cost effectiveness, impact on health and safety, contribution to the existing transportation network, and impact to disadvantaged populations.

conform to the development types in the existing general plans. The plan included the anticipated General Plan updates for Fresno and Clovis.

This is the adopted preferred scenario and includes land uses based on the recently updated general plans of Fresno and Clovis which incorporated Blueprint smart growth goals. This scenario includes the foothill development projects (Friant Ranch and Millerton New Town) that were already approved by the County of Fresno. This scenario allows incorporated cities to grow at historical rates and prioritizes denser, infill development in urban areas.

Scenario C

Scenario C was developed by the RTP Roundtable at the request of community-based organizations who felt that the Fresno and Clovis general plan updates would not sufficiently address environmental concerns. The primary land use strategy was characterized by shifting foothill growth into the City of Fresno and constraining unincorporated county growth to 10 existing communities.

This scenario did not include the Friant Ranch and Millerton New Town projects that were already approved by the County of Fresno. Instead, the growth from unincorporated Fresno County was directed to the downtown and corridors in the City of Fresno. This scenario allowed for little growth in the other existing incorporated cities, which was not acceptable to them.

Scenario D

After scenarios A, B, and C were presented to the public, Scenario D was proposed by community-based organizations. The land use strategy is characterized by higher density for new growth and a shift of foothill growth into smaller existing rural communities and downtown Fresno.

The scenario greatly increased density for new development but because of increased rural growth, did not show significant reduction in GHG compared to the preferred scenario. This scenario also did not include the approved Friant Ranch and Millerton New Town developments. This scenario was not chosen in part because the extreme density allocated to downtown Fresno could not be accommodated by the existing general plan.

Preferred Scenario

Scenarios A, B, and C were presented to the public at workshops and compared using the 10 performance indicators. Approximately 350 people selected their preferred scenario and submitted comments which were provided to Fresno COG committees and Policy Board for review. Scenario D, having been developed later, was presented to city councils and available online before committee review. All four scenarios showed improvements compared to the status quo across measures such as fewer acres of land consumed per person, more agricultural land preserved, and a reduction in vehicle miles traveled (VMT).

The RTP Roundtable, Transportation Technical Committee (TTC), Policy Advisory Committee (PAC) and COG staff recommended that the Policy Board select Scenario B as the preferred SCS Scenario, which was subsequently selected by the Policy Board in November 2013. Scenario B was selected for its ability to meet greenhouse gas reductions while providing co-benefits that allow residents to reduce their VMT by having shorter trip distances and more transit, bicycle and pedestrian amenities. Scenario B allows jurisdictions to continue growing at historic trend rates, while limiting greenfield development because of the County's policy of directing growth to existing urbanized areas and the cities' policies of growing within existing spheres of influence. This scenario was also the most consistent with local land use authority because it reflects the most recent local general plan updates. The preferred scenario includes two greenfield developments (Friant Ranch and Millerton New Town) that were approved by the County Board of Supervisors several years before SCS planning began.

C. 2014 RTP/SCS Land Use and Transportation Strategies

The ability of the SCS to reduce VMT and related GHG emissions relies in part on the decreased trip distances that would result from more compact development and a greater mix of land uses. Additional reductions in VMT and GHG emissions are anticipated from coordinated transportation strategies that will help residents reach their destinations with alternative modes to the single occupancy vehicles (SOV).

1. Growth Strategy

The growth forecast in the 2014 RTP/SCS was allocated to the respective jurisdictions according to the existing and pending updates to general plans, approved specific plans, and historical trends.

The 2014 RTP/SCS differs from the business-as-usual case represented by the 2011 RTP because the 2014 RTP/SCS anticipates different land use policies introduced in the pending City of Fresno general plan update, and the recent general plan updates of cities like Clovis, Reedley and Selma. This change in land use strategy incorporates Valley Blueprint policies for infill and mixed use development with more multifamily housing and higher density near activity centers that provide for pedestrian and bicycle access. The recently adopted general plan in Clovis emphasizes a jobs-housing balance and encourages infill development that can shorten trip distances between jobs and housing.

New growth is encouraged to take place within the existing spheres of influence for the 15 incorporated cities and includes both infill and greenfield development. Growing within the existing sphere of influence reduces development pressure on the agricultural land that is important to maintaining the agricultural economy and helps to minimize leapfrog development. This development strategy leads to more efficient provision of public services to new growth areas and indirectly encourages increased density of new development. The County of Fresno general plan supports the policy of maintaining new growth within incorporated areas. For the growth that will occur in the unincorporated county by 2035, two thirds would be located within two development projects northeast of Fresno—Friant Ranch and Millerton New Town.

This growth strategy shifts the distribution of the population slightly so that in 2035, proportionally more people will live in the Fresno-Clovis metro area and a slightly lower proportion of residents will live in the smaller cities and incorporated areas.

A large portion of the region's growth would be accommodated in the City of Fresno. The City's general plan update proposes 45 percent of new growth in designated infill areas. For example, Fresno's general plan update would direct job and housing development along high use corridors, such as Blackstone Avenue, to accommodate growth near transit service and in close proximity to other destinations that can allow for shorter trip times.

The policies in the 2014 RTP/SCS reduce the footprint of future development. As shown in Table 3 the 2011 RTP would have resulted in the consumption of 22,308 acres of land for new development, including 9,462 acres of important farmland[8]. The 2014 RTP/SCS would consume 34 percent less land by accommodating forecasted growth on 14,675 acres of land and reduces the amount of farmland consumed by about 38 percent. In response to concerns from community-based organizations, the Fresno COG PAC was tasked to develop agricultural mitigation measures to address the potential loss of important farmland within spheres of influence.

Table 3: Land Consumption for New Development (2008-2035)

	2011 RTP	2014 RTP/SCS	Difference
Total acres developed	22,308	14,675	-34%
Important farmland acres developed	9,462	5,857	-38%

Compared to the 2011 RTP, the 2014 RTP/SCS:

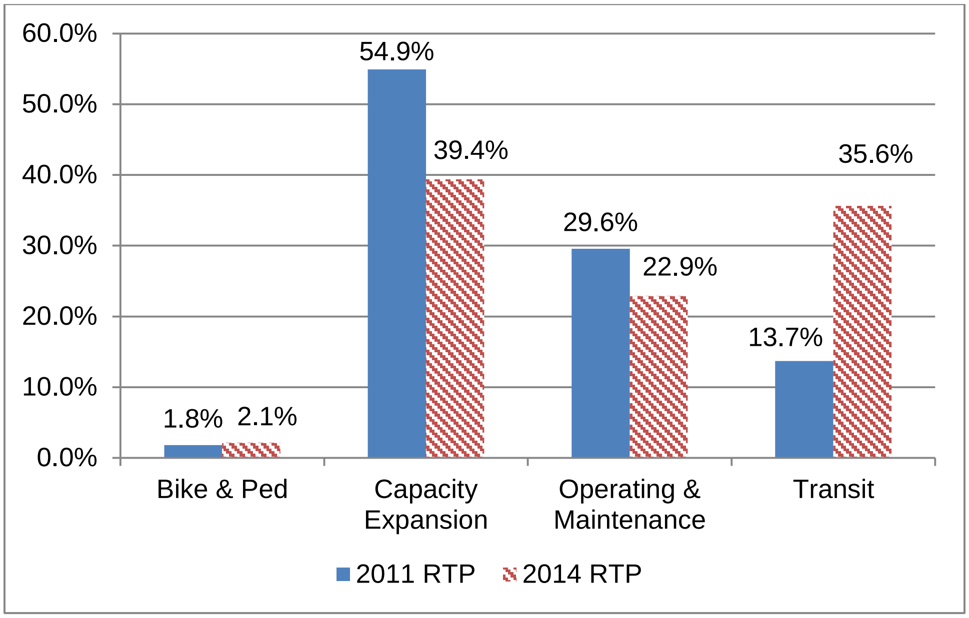
- Increases the percentage of new multi-family housing, from 22 percent to 47 percent of total new housing units; and reduces the percentage of new single family housing from 78 percent to 53 percent, by 2035
- Nearly doubles the density of new residential development by 2035
- Increases the average population density (persons per acre) from 13.9 persons per acre to 21.1 persons per acre by 2035

[8] Important farmland includes prime farmland, farmland of statewide importance and unique farmland.

2. Transportation

The 2014 RTP/SCS differs notably from the 2011 RTP (Figure 3) with the increased investments in transit and active transportation and the reductions in funding for roadway projects.

Figure 3: Distribution of Total RTP Expenditures by Project Type



Source: FCOG 2014e

Compared to the 2011 RTP, the preferred growth scenario and transportation project list for the 2014 RTP/SCS improves accessibility to transit by locating over 30 percent of new housing and 63 percent of new employment within a half-mile of Fresno and Clovis transit stations.

a) Constrained Network

The 2014 RTP financially constrained project list reflects a budget of over $4.4 billion. The financial assumptions used to develop the constrained project list assumed local, state and federal sources to remain constant through the same or similar funding programs and used cost projections provided by local jurisdictions and transit operators.

One source of local funding, Measure C Extension, was approved by voters in 2006 and provides a 20 year, half cent sales tax to fund multi-modal transportation improvements. Almost 25 percent of the total revenue from Measure C is allocated to public transportation, 30 percent to capacity increasing projects, and 35 percent to road maintenance and active transportation facilities. The measure is expected to generate $1.7 billion in new revenues for transportation improvements through 2027. Measure C also includes several provisions to help implement multi-modal transportation. For example, it requires that every highway, arterial, or collector within the County constructed or reconstructed in whole or in part with Measure C funds include accommodations for bicycle travel. It also requires that a jurisdiction have a bicycle master plan to qualify for bike infrastructure funding. Lastly, Measure C funds many transportation demand measures or strategies such as carpool incentives and vanpool subsidies.

b) Streets & Roads

The 2014 RTP/SCS allocates about 35 percent of the budget for public transit, an increase from the 13 percent allocated in the 2011 RTP.

The 2014 RTP invests almost 40 percent of the RTP budget in general capacity increasing projects to maintain efficient travel of residents and goods. This is a 16 percent decrease compared to the 2011 RTP. The project list includes widening sections of regionally important roadways such as SR 41 and 180 as well as improving SR 99 interchanges and adding capacity to local roads, mainly concentrated in or near the metro Fresno-Clovis area.

The operations and maintenance project list for streets and roads mainly consists of pavement overlay and rehabilitation to maintain the current roadway network. The project list also includes the repair and upgrading of bridges as well as the installation and coordination of dozens of traffic signals.

c) Transportation Demand Measures

Many vanpools serve distant worksites such as agricultural facilities and prisons that could not effectively be served by transit and require long commutes to and from urbanized residential areas.

Fresno COG incorporated several transportation demand strategies in the 2014 RTP/SCS to reduce the need for SOV travel. One program is Fresno COG's sponsorship of Rideshare programs and reduced senior fares for taxi rides. The Measure C Extension allocates close to $20 million through 2026 to fund carpool and vanpool programs. Another strategy is the Valley Air Districts's Employer Based Trip Reduction Rule (9410) that requires employers of a certain size to encourage employees to reduce SOV trips.

d) Transit

The 2014 RTP/SCS plans for an expansion and improvement of the public transit network. The infill and compact land use strategies can potentially make transit service more cost effective by allowing transit agencies to serve more potential riders along routes. Transit projects include passenger amenities such as bus stop shelters and accessibility improvements such as braille bus stop numbering. The RTP transit project list also includes allocation for updating transit fleet and maintenance vehicles to compressed natural gas (CNG) and zero emission buses.

As independent operators, FAX, Stageline, and FCRTA cooperate with Fresno COG on a voluntary basis for route coordination and long-term planning strategies. With the cooperation of transit providers, Fresno COG plans to coordinate these services through a regional long-range transit plan that will provide a clearer picture for future investments and develop a more comprehensive regional transit system. An application for funding to conduct this regional long-range transit plan is currently pending with Caltrans.

The increase in funding towards transit projects compared to the 2011 RTP is primarily due to investments in the new bus rapid transit (BRT) system in the City of Fresno. This BRT system includes five corridors that link existing and planned activity centers and is intended to support the increasing density and mix of land uses in the city. The first planned BRT corridor (Kings Canyon Corridor) is already under construction.

Before and since the adoption of the RTP/SCS, FCRTA has collaborated with Fresno COG and community representatives to identify new and expanded service routes. The service changes include Lanare Transit, which will offer a shuttle service along the southern corridor of Fresno County as well as inter-city routes, and the expansion of the Huron Transit Inter-City into Coalinga which will expand from 5 to 7 hours of service per day. These new and expanded transit services scheduled to begin in July 2014 help to improve access to public transit in the rural areas of Fresno County.

e) Bike and Pedestrian Facilities

The 2014 RTP/SCS will add 500 bike lane miles and 120 sidewalk lane miles.

The 2014 RTP/SCS includes $94 million for bike and pedestrian projects, which represents 2.1 percent of the total budget, and is an increase from the 1.8 percent budget allocation in the 2011 RTP. These projects would result in the addition of more than 500 (lane) miles of bike lanes and 120 miles of sidewalks by 2040. In part because of the stipulations of Measure C funding and the complete streets policies of many Fresno COG member agencies, approximately 164 additional miles of bike and pedestrian improvements will be built as part of road construction projects.

The City of Fresno has begun to implement a bicycle plan by requiring the installation of bike racks in new development, adding several miles of bikeway, and installing bike racks on the entire transit fleet. In the City of Clovis, the Stageline transit fleet and newer buses of the Rural Transit Agency's intra-city fleet are equipped with bike racks. The City of Clovis provides for bike lanes along designated streets in accordance with adopted specific plans and has implemented bikeways along segments of several major streets.

The RTP anticipates that the other cities and Fresno County will continue to implement the Regional Bicycle & Recreational Trails Master Plan and local Bicycle Transportation Plans as funding allows.

D. RTP/SCS Equity Analysis

As a recipient of federal transportation funding, Fresno COG prepares an environmental justice (EJ) analysis of its RTP, per Executive Order 12898. Fresno COG's EJ equity analysis is intended to assess whether designated EJ communities share equitably in the benefits of the 2014 RTP/SCS's investments without bearing a disproportionate share of the burdens. The Federal Highway Administration (FHWA) sets the policy and criteria for EJ analysis.

Fresno COG formed an EJ Taskforce to examine the EJ outcomes of its RTP/SCS. The taskforce comprised representatives from minority and senior citizen groups as well as representation of environmental, health, housing, faith and other community organizations.

The EJ Taskforce first set out to identify the communities to designate for analysis by exploring parameters outside of the FHWA low-income and minority thresholds. The EJ Taskforce determined that by using a low-income threshold of 150 percent at or below the household poverty level, 35 percent of the total county population met the analysis threshold. The EJ Taskforce also further defined the EJ communities within Fresno County using vulnerability factors that were sensitive to specific characteristics of the county and could be considered alongside the minority and low income thresholds. These vulnerabilities included, among others: no vehicle availability, linguistic isolation, housing cost burden, and single parent households.

The FHWA requested that Fresno COG focus on only the minority and low-income thresholds instead of the additional vulnerability factors recommended by the Taskforce. Using the FHWA parameters, EJ areas make up 35 percent of the total traffic analysis zones (TAZ) in Fresno County. Many of these EJ TAZs are located in rural areas or in South Fresno. Within these EJ TAZs, the minority population is 89 percent and the low income population is 58 percent. The work of the EJ Taskforce has created a foundation of information upon which Fresno COG can work with the Taskforce to address the needs of minority and low-income rural transit riders in Fresno County.

Fresno COG used five performance measures to determine how the EJ communities fared with the implementation of the RTP/SCS compared to a 2008 base year and compared to the impacts expected for non-EJ communities. Table 4 represents ARB staff's summary of Fresno COG's performance measures and their EJ analysis (2014 RTP/SCS, Chapter 3).

Table 4: EJ Performance Measures and Results

Performance Measure	Result
Accessibility and Mobility: Average AM and PM trip times by mode throughout the county	EJ communities showed equal or shorter average travel times than non-EJ communities in all instances except rural transit trips.
Cost-effectiveness: Person miles traveled per $1,000 transit investment	The daily transit passenger miles travelled per $1,000 invested is higher for the EJ communities compared to the non-EJ communities.

Equity: Person miles travelled with comparison of percentage of investment in EJ and non EJ TAZs	EJ communities would have a higher benefit from expenditure (53 percent) compared to non-EJ counterparts.
Reliability: Percent of on-time arrival and highway congestion	Both EJ and non-EJ communities would have a reduction in percentage of VMT at roadway level of service E or worse. However, EJ areas experience about five percent higher rates of roadway congestion possibly due to proximity of many EJ communities to the congested parts of freeways in the Fresno-Clovis area.
Consumer satisfaction: LOS and trip delay	EJ communities fare better than in no build scenario.

Source: FCOG 2014a

The EJ analysis demonstrates that EJ communities would receive an equitable portion of benefits from the 2014 RTP/SCS. In the case of mobility and accessibility, there are countywide improvements in travel times from the EJ TAZs to employment, schools and parks except for populations outside of the Fresno-Clovis area. In terms of equity, EJ communities benefit more from transit investments—53 percent greater investment. Although the RTP/SCS notes that improvements are needed, the analysis concluded that EJ communities are not excessively burdened by impacts of projects and do share equally in the benefits.

E. Public Outreach Process

Fresno COG staff solicited input and feedback from stakeholders, interested organizations, and members of the public on the direction and strategies of the RTP/SCS. Throughout the RTP/SCS development process Fresno COG hosted a total of 18 workshops, 12 roundtable meetings, seven focus groups, five EJ Taskforce meetings, and conducted professional polling. Through these efforts they reached a combined 1,700 participants.

Fresno COG organized a 35 member RTP Roundtable to reflect a mix of stakeholder perspectives. Sixteen members were member agency staff, 16 were stakeholder representatives and three were representatives of the public-at-large. The purpose of this Roundtable was to provide comments, community-based consensus, and to support the staff and various committees in the development and preparation of the 2014 RTP/SCS

To guide the public participation process, the Fresno COG Policy Board adopted a Regional Transportation Plan Public Outreach Strategy in September 2012, which was developed with input from the general public, the RTP Roundtable, TTC, PAC and Policy Board.

The eight MPOs in the SJV collaborated to develop a valleywide Public Outreach Strategy to support each of their individual RTP/SCS processes. They developed a common branding scheme and suite of outreach tools including: factsheets, press releases, a Valley Visions logo, and a 3 minute video (available in English, Spanish and Hmong). They also shared an online banner and radio and newspaper advertisements to raise public awareness of the RTP/SCS planning process.

During the development of the alternative SCS scenarios, Fresno COG's website posted information relevant to the process such as pages for SB 375, public participation, the RTP financial element, calendar listings, agendas, presentations, videos, minutes, and committee processes. Public workshops were publicized through posters and flyers distributed through transit agencies, community organizations and mini-grant recipients; email announcements to government agencies, businesses and community partners; website posts of current information and drafts; Fresno COG's Facebook page and Twitter; library website; and newspaper and online advertisement.

Public Workshops

In November 2012, Fresno COG hosted its first public workshop to gather community input on the development of the SCS. One hundred fifty attendees were asked to rank transportation spending priorities and issues related to the SCS such as importance of public safety, the economy and public health. Attendees also participated in a hands-on mapping exercise to identify their transportation and land use choices, which became the basis for Scenario A, discussed earlier in this report.

In order to ensure widespread and diverse public input early in the RTP/SCS process, Fresno COG provided $3,000 mini-grants in May 2013 to seven community-based organizations and agencies. This funded ten workshops in the cities of Fresno, Kingsburg, Kerman, Huron and Clovis. Translators were present and materials were available in five languages--English, Spanish, Hmong, Punjabi and Laotian. Free transportation, childcare and dinner was provided to attendees. The combined workshop attendance totaled 250 people.

As discussed above in Section II. B. SCS Scenarios, Fresno COG hosted six workshops and one video conference in August and September of 2013 to present and solicit feedback on alternative SCS scenarios A, B and C. Summaries of this feedback were submitted to the RTP Roundtable, TTC, PAC and Policy Board for consideration to help inform the selection of a preferred scenario. The fourth Scenario D was not presented at these workshops but was available on the Fresno COG website for over two months and presented publicly to city councils before review by the RTP Roundtable, TTC, PAC and Policy Board.

The Draft RTP/SCS plan was released on March 21, 2014 by the Fresno COG Policy Board which began the 55-day comment period on the draft and accompanying Environmental Impact Report. During this time, Fresno COG held two public hearings to receive comments. In total, 16 letters were received, which are included in Appendix E of the RTP/SCS along with the COG's formal written responses. The comment letters raised various issues such as questions about specific projects, inclusion of public participant preferences, and requests for implementation such as a needs assessment and grant program.

F. Plan Implementation

The Final RTP/SCS was adopted on June 26, 2014. Fresno COG plans to track progress through its Overall Work Program and Annual Budget process which provides an opportunity to allocate staff and funding resources to implement strategies. Fresno COG also plans to periodically monitor the actions of other agencies and local jurisdictions in implementing the strategies in the plan.

In May 2014, a coalition of community organizations put forward three proposals for SCS implementation measures that the Fresno COG Policy Board directed the PAC to discuss. As part of RTP/SCS adoption, these proposals were accepted by the Policy Board and the region is currently moving forward to implement these measures:

1) **Transportation Needs Assessment**: to help inform transportation investment decisions. The kick-off meeting was held on November 4, 2014. At the meeting, the group discussed inventorying existing and planned bicycle and pedestrian infrastructure, then conducting a gap analysis, finding funding, and finally researching health data.
2) **Sustainable Planning and Infrastructure Grant Program:** to help cities and the county implement the region's SCS goals. A peer exchange event was held on August 20, 2014. Fresno COG has committed to evaluating the needs of the region by committing $100,000 in the 2014-2015 Overall Work Program to conduct a needs assessment in disadvantaged communities.
3) **Natural and Working Lands Conservation Policies:** to help agencies understand the impact of projects on farmland conversion and to identify potential preservation policies and agriculture mitigation measures.

Regional Active Transportation Plan

In August 2014 the CTC awarded Fresno COG an Active Transportation Program Grant to fund a Regional Active Transportation Plan. The plan will guide efforts to improve bicycling and walking conditions at the local level throughout the Fresno County region and will serve as a blueprint for the future of walking and bicycling in the region.

Local Planning Assistance

Most of the cities in Fresno County are small rural communities with populations under 25,000 that often do not have the resources to employ more than one full-time planner. Fresno COG employs a local planner to act as a liaison between Fresno COG and the 13 smaller cities within Fresno County and to provide technical assistance and information to promote sustainable development within these small cities. Known as a circuit planner, this employee provides capacity support to the smaller cities to integrate the Blueprint Smart Growth principles into their planning processes and coordinate transportation project development. As of November 2014, 12 of the cities are actively working with the circuit planner to adopt and integrate Blueprint principals into general plans, master plans, specific plans, and zoning ordinances.

III. ARB Staff Technical Analysis

SB 375 calls for ARB's "acceptance or rejection of the MPO's determination that the Sustainable Communities Strategy (SCS) would, if implemented, achieve the greenhouse gas emission reduction targets" in 2020 and 2035. Fresno COG's quantification of GHG emissions reductions in the SCS is central to its determination that the SCS would meet the targets established by ARB in September 2010. The remainder of this report describes the method ARB staff used to review Fresno COG's determination that its SCS would meet its targets, and reports the results of staff's technical evaluation of Fresno COG's quantification of passenger vehicle GHG emissions reductions.

Government Code section 65080(b)(2)(J)(i) requires the MPO to submit a description to ARB of the technical methodology it intends to use to estimate GHG emissions from its SCS. Fresno COG's technical methodology in September 2012 identifies its transportation modeling system, which includes the regional travel demand model, model inputs and assumptions, land use projections, growth forecast, performance indicators, and sensitivity analyses, as the technical foundation for its quantification.

Fresno COG determined that the SCS would meet a 5 percent per capita reduction in GHG emissions from passenger vehicles by 2020, and a 10 percent per capita reduction by 2035[9]. ARB staff's evaluation of Fresno COG's SCS and its technical documentation indicates that if implemented, the SCS would meet the GHG emissions reduction targets set by the Board.

A. Application of ARB Staff Review Methodology

Review of Fresno COG's quantification focused on the technical aspects of regional modeling that underlie the quantification of GHG emission reductions. The review is structured to examine Fresno COG's modeling tools, model inputs, application of the model, and modeling results. The general method of review is outlined in ARB's July 2011 document entitled "Description of Methodology for ARB Staff Review of Greenhouse Gas Reductions from Sustainable Communities Strategies Pursuant to SB 375". To address the unique characteristics of each MPO region and modeling system, ARB's methodology is tailored to and expanded for the evaluation of each MPO. Fresno COG provided a copy of its travel model to ARB staff which enabled a first-hand assessment of the model's structure and performance.

ARB staff evaluated how Fresno COG's models operate and perform when estimating travel demand, land use impacts, and future growth, and how well they provide for quantification of GHG emissions reductions associated with the SCS. In evaluating

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[9] FCOG 2014f

whether or not Fresno COG's models are reasonably sensitive for this purpose, ARB staff examined issues such as:

- How does the growth forecast reflect the recent economic recession?
- What is the basis for allocation of land use changes?
- How well does Fresno COG's travel demand model replicate observed results?
- Are cost assumptions (fuel price and vehicle operation cost) used in the model reasonable?
- How sensitive is Fresno COG's model to changes in key land use and transportation variables as compared with the empirical literature?

To help answer these and other questions, ARB staff used publicly available information in Fresno COG's SCS, and accompanying documentation including the RTP technical appendices and the model description and validation report. Because Fresno COG provided a copy of its travel model, ARB staff was able to run and perform independent testing. In addition, Fresno COG provided clarifying information, sensitivity analyses, and a data table, as listed in Appendix A.

Four central components of Fresno COG's GHG quantification methodology and supporting analyses were reviewed for technical soundness and general accuracy:

- Data Inputs and Assumptions for Modeling Tools
- Modeling Tools
- Model Sensitivity Analyses
- Performance Indicators

ARB staff's technical analysis was facilitated by having access to Fresno COG's travel model, which was provided by Fresno COG and run by ARB staff.

Data Inputs and Assumptions for Modeling Tools

Fresno COG's key model inputs and assumptions were evaluated to confirm that they represent current and reliable data, and were appropriately used in their model. Specifically, a subset of the most relevant model inputs were reviewed, including: 1) regional socioeconomic characteristics, 2) the region's transportation network, 3) travel inputs, and 4) cost assumptions. In evaluating these four input types, model inputs were compared with underlying data sources. The assumptions Fresno COG used to forecast growth and VMT were also reviewed. This involved using publicly available, well documented sources of information, such as national and statewide survey data on socioeconomic and travel factors. ARB staff also evaluated documentation of regional forecasting processes and approaches.

Modeling Tools

ARB staff assessed how well Fresno COG's travel demand model (TDM) replicates observed results based on both the latest inputs (socioeconomic, land use, and travel data) and assumptions used to model the SCS. Fresno COG's Envision Tomorrow land use model documentation and results were reviewed to assess whether an appropriate methodology was used to quantify the expected reduction in GHG emissions from its

SCS. Fresno COG's modeling practices were also compared against CTC's "2010 California Regional Transportation Plan Guidelines," the Federal Highway Administration's (FHWA) "Model Validation and Reasonableness Checking Manual," and other key modeling guidance and documents.

Model Sensitivity Analysis

Sensitivity testing is often used to assess whether a model is reasonably responsive to changes of key inputs, including changes to land use and transportation factors. These tests often involve systematically changing model input variables and measuring variations in output variables. They can also be performed by examining variations in independent and dependent variables across a dataset, and evaluating the correlations between the variables. Fresno COG conducted sensitivity tests of its travel model to support its GHG emissions quantification analyses.

The results of Fresno COG's sensitivity tests were compared to those found in the available empirical literature[10]. As part of the sensitivity analysis review, responsiveness of Fresno COG's travel demand model to changes in the following input variables were examined:

- Auto operating costs
- Transit frequency
- Residential density
- Proximity to transit
- Household income distribution

Regional Performance Indicators

Performance indicators help explain changes in VMT and related GHG emissions that are expected to occur, whether through changes in travel modes, vehicle trip distances, or through some other means. Fresno COG developed several performance indicators to evaluate the effect of implementation of the 2014 RTP/SCS on changes in VMT and GHG emissions. These performance indicators include land consumption, jobs/housing balance, distance of housing and employment from transit stations, passenger VMT, mode share, speed changes, vehicle delay, travel time distribution, and number of non-motorized trips. ARB staff performed a qualitative evaluation to determine if increases or decreases in a subset of these individual indicators are directionally consistent with Fresno COG's modeled GHG emissions reductions.

[10] Empirical literature elasticities were taken from a series of empirical literature reviews commissioned by ARB. These reviews can be accessed on ARB's website at: http://arb.ca.gov/cc/sb375/policies/policies.htm

B. Data Inputs and Assumptions for Modeling Tools

Fresno COG's key model inputs and assumptions were evaluated to confirm that model inputs represent current and reliable data, and were used appropriately. Specifically, a subset of the most relevant model inputs were reviewed, including: 1) regional growth forecast, 2) land use development patterns, 3) the region's transportation network, and 4) cost assumptions. In evaluating these four input types ARB staff reviewed the assumptions Fresno COG used to forecast growth and VMT and compared model inputs with underlying data sources. This involved using publicly available, authoritative sources of information, such as national and statewide survey data on socioeconomic and travel factors, as well as region specific forecasting documentation.

1. Demographics and the Regional Growth Forecast

Demographic data and forecasts describe a number of key characteristics used in travel demand models. The regional forecast forms the vision of how many people will live in the region, how many jobs the region will have, and the anticipated number of households.

The demographic forecasts for Fresno County were conducted by the Planning Center in 2012. The forecasts, shown earlier in **Table 2**, were confirmed to be valid in 2013 when the DOF released projections for Fresno County that differed by less than two percent for each year. Forecasts were based on a least-squares linear curve. The main population, housing and employment forecasts used the projections of several trends including: household trend, total housing unit trend, housing construction trend, employment trend, cohort-component model, population trend, average household size trend, and household income trend.

a) Population

The county is projected to grow at a rate of 1.8% annually between 2010 and 2040 which is less than the 2.4% growth rate observed between 1970 and 1990, and slightly higher than the 1.7% annual growth rate between 1990 and 2010.

b) Employment

The employment forecast was determined by using at-place employment data by sector from the State of California Employment Development Department. Future employment levels depend on the health of agricultural industry since it is directly and indirectly a major source of employment. Employment in Fresno County is forecast to increase by about 92,000 jobs between 2005 and 2035 but this is not proportionate to the higher rate of population growth during this period.

c) Households

Household sizes are projected to increase slightly from 2.9 persons per household in 2008 to 3.1 persons per household in 2035. This has an impact on the total amount of housing units needed because some of the total growth in household population will be accommodated by existing units and fewer new development units because each household on average will contain more people. The forecast for housing units is based on estimates by DOF and projections based on the number of units constructed. These forecasts indicate that multi-family housing will increase at a faster rate than single-family housing in the region.

2. Current and Future Land Use Development Patterns

Fresno COG used Envision Tomorrow, an urban and regional planning tool, to forecast future land use changes.

The land use planning process in Envision Tomorrow starts with modeling the building types (e.g. mixed-use buildings, medium-density residential building, single-family dwelling units) that are existing or planned in the Fresno COG region in the base year and forecasted years (i.e. 2020, 2035, 2040). These building types define, all the "places" (e.g. buildings, streets, amenities) where people live, work and have activities in the region.

Current land use: General Plan and Envision Tomorrow development types

There are 15 cities in Fresno County that adopt unique comprehensive land use plans (i.e. general plans). In developing the 24 development types for the Envision Tomorrow tool, Fresno COG worked with the local jurisdictions to ensure that the model reflected the land use development types in the local plans.

Future Land Use Pattern

The land use pattern in Fresno COG's preferred scenario anticipates an increase in housing density through multi-family and infill development and an increase in jobs and housing near activity centers and corridors. These indicators of future land use are described in further detail later in this report in "SCS Performance Indicators".

Future land use patterns were established by combining the growth forecasts for each city with the likely development type based on the most recent planning assumptions for each jurisdiction. The various planning characterizations from each jurisdiction were assigned to one of 24 development types in the Envision Tomorrow tool. Fresno COG shared the outputs from the Envision Tomorrow tool with each jurisdiction to confirm that the modeled pattern of growth was consistent with how they expected their city to grow.

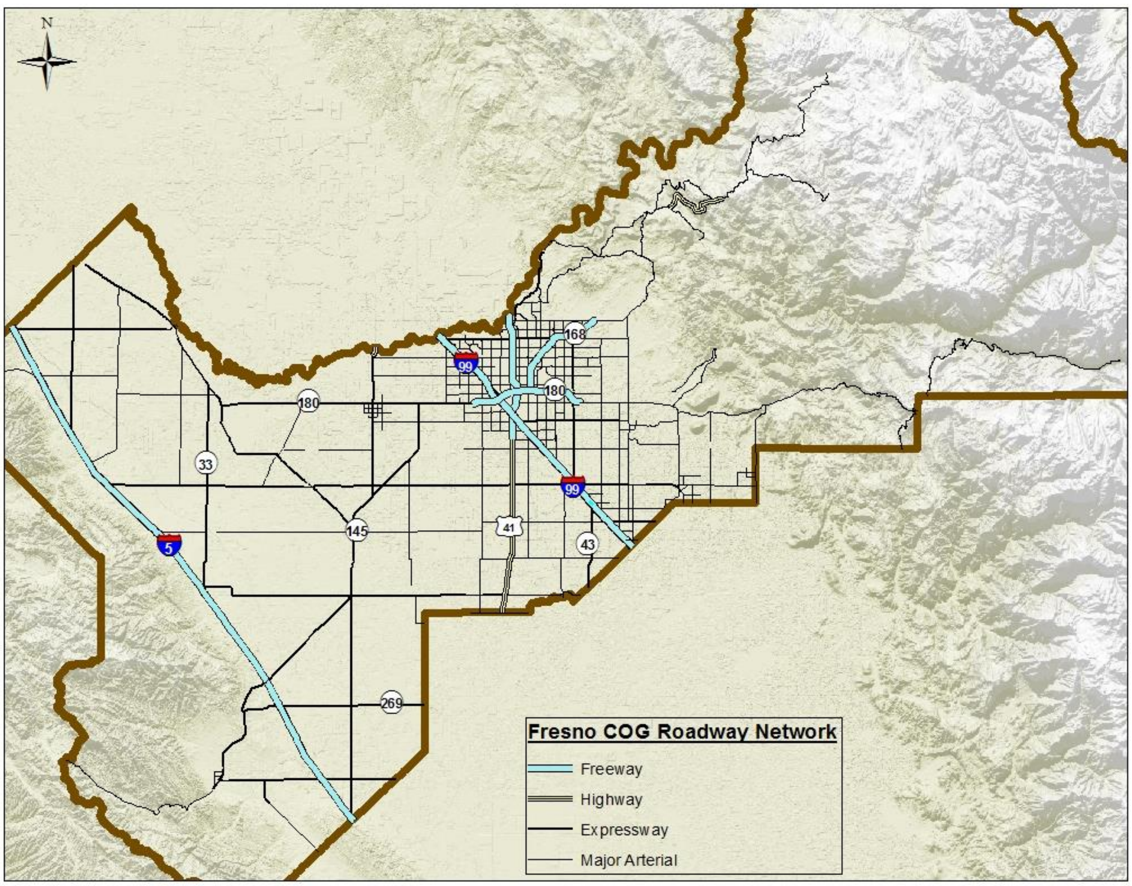
3. Transportation Network Inputs and Assumptions

The transportation network is a map-based representation of the transportation system serving the Fresno COG region. One part of that transportation network is the roadway network, which consists of an inventory of the existing road system, and highway travel times and distances. The other part of the transportation network is the transit network, which usually contains data such as route name, stop locations, transit fares, headway, and type of transit service. ARB staff reviewed the Fresno COG regional roadway network, transit network and network assumptions such as link capacity and free-flow speeds. The methodologies Fresno COG used to develop the transportation network and model input assumptions is consistent with guidelines given in the National Cooperative Highway Research Program (NCHRP) Report 365.

a) Roadway Network

Fresno COG's roadway network is a representation of the automobile roadway system, which includes freeway, highway, expressway, arterial, collector, local, and freeway ramps in the region. Figure 4 shows the existing freeway, highway, expressway, and major arterials in the region as reported by Fresno COG. The roadway network provides the basis of estimating zone-to-zone travel times and costs for the trip distribution and mode choice steps of the modeling process, and for trip routing in vehicle assignments.

Figure 4: Existing Fresno COG Major Roadway Network



Roadways in the network are also categorized by adjacent development (i.e. central business district, fringe, urban, suburban, or rural) and terrain (i.e. flat, rolling or mountains). Fresno COG's travel demand model uses facility type classifications consistent with the Federal Functional Highway Classification system. Table 5 summarizes the reported lane miles by facility type in 2008.

Table 5: Base Year Roadway Lane Miles by Facility Type

Facility Type	Lane miles (2008)
Freeway	662.6
Highway	691.97
Expressway	643.58
HOV	0
Arterial	2157.6
Collector	2202.04
Local	11.4
Interchange	20.19

b) Link Capacity

Link capacity is defined as the number of vehicles that can pass a point of roadway at free-flow speed in an hour. One important reason for using link capacity as an input to the travel model is for congestion impact, which can be estimated as the additional vehicle-hours of delay traveling below free-flow speed. Fresno COG staff made assumptions for link capacities based on the 2000 Highway Capacity Manual (2000 HCM). Table 6 summarizes the link capacity assumptions by facility type and by terrain. The characteristics of each link are also determined by terrain, facility type, and area type using Bureau of Public Roads (BPR) formulas. The link capacities used in the Fresno COG highway network are consistent with the recommended link capacities in the HCM.

Table 6: Link Capacity by Terrain

Facility Type	Fresno COG Link Capacity Range by Terrain (vehicles/hour/lane)		
	Flat	Rolling	Mountain
Freeway	1,750 to 2,100	1,580 to 1,800	1,310 to 1,500
Highway	1,300 to 1,680	1,060 to 1,300	570 to 700
Expressway	800 to 1,155	650 to 1,300	350 to 700

Arterial	750 to 945	610 to 1,300	330 to 700
Collector	700 to 735	570 to 1,300	310 to 700
Local	600	550 to 1,000	330 to 600
Ramps	1,250 to 1,900	1,250 to 1,800	1,250 to 1,500

c) Free-Flow Speed

Free-flow speed is used to calculate the shortest travel time between two points in the highway network. Factors such as the prevailing traffic volume on the link, posted speed limits, adjacent land use activity, functional classification of the street, type of intersection control, and spacing of intersection controls can affect link speed. Table 7 summarizes the free-flow speed assumptions used in the Fresno COG travel demand model.

Table 7: Free-Flow Speed Assumptions

Facility Type	Fresno COG Free-Flow Speed Assumptions by Terrain (mph)		
	Flat	**Rolling**	**Mountain**
Freeway	55 to 70	65 to 70	65
Highway	40 to 45	40 to 45	40 to 45
Expressway	40 to 55	50 to 65	40 to 55
Arterial	25 to 55	30 to 45	30 to 45
Collector	35 to 50	50	25 to 40
Local	25 to 40	50	25 to 40
Ramps	50	50	50

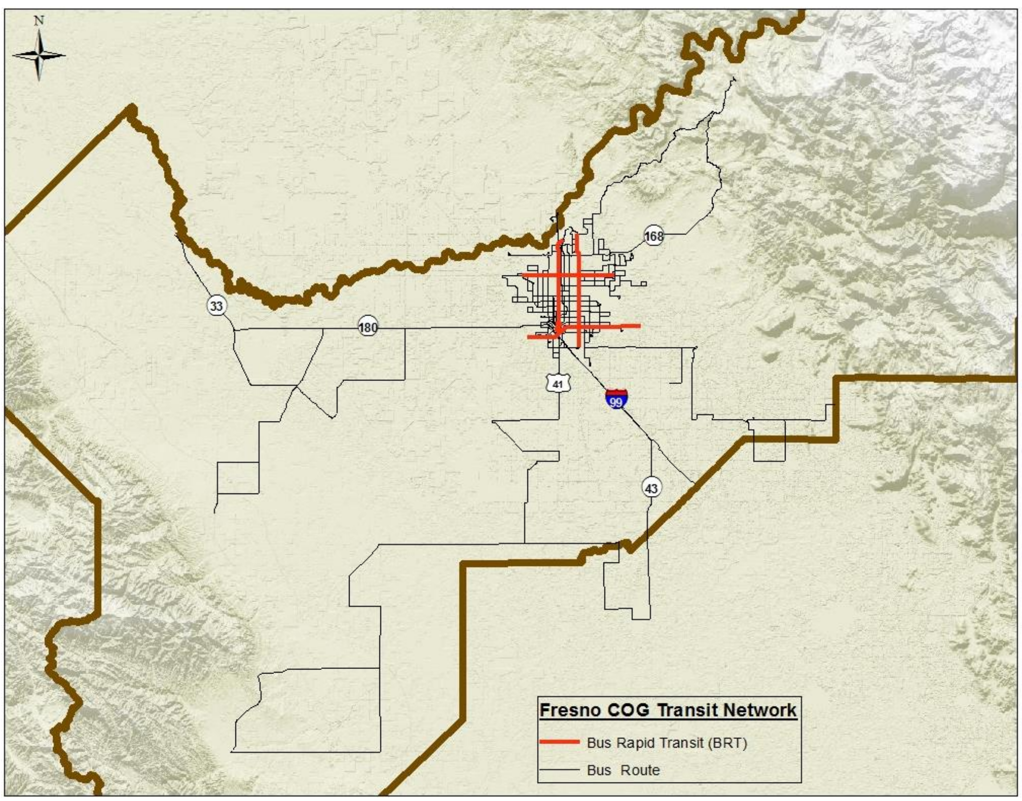
The methodology used in estimating highway free-flow speeds in the Fresno COG region was reviewed. Fresno COG's estimation of free-flow speed based on the posted speed is consistent with the recommended practice indicated in the NCHRP Report 365.

d) Transit Network

Fresno COG staff built the transit network using the complete roadway network to which transit routes information was added. Figure 5 also shows the existing bus service coverage and the planned BRT coverage by 2040 in the region. The purposes of development of a transit network are verification of access links and transfer points, performance of system level checks on frequency and proximity between home and transit station/stop, and relating transit speed to highway speeds.

Fresno COG staff coded the transit network to reflect walk/bike access, drive access, park-and-ride lots, highway based (i.e. bus) and non-highway based (i.e. rail) transit in the region. Some attributes coded in the transit network include transit fare, travel time, park-and-ride locations, and maximum distance for walk and drive to transit stops. Fresno COG staff derived transit bus travel times from the highway network, with a delay factor to account for stops and slower operating speeds. The travel demand model assumes a walking speed of three miles per hour for walk access when estimating transit travel time.

Figure 5: 2008 Fresno COG Transit Network



Source: Fehr & Peers 2014

The description of Fresno COG's transit network development was compared with procedures discussed in the NCHRP Report 365 and USDOT-FHWA Manual. Fresno COG followed acceptable practice, consistent with these reports. In future model updates, Fresno COG can provide additional information on operation miles or service hours by transit service. Fresno COG can also include bike and pedestrian facilities (e.g. bike path, bike lane) in the transit network to reflect walk- or bike-access to transit stations, which may increase the model's sensitivity to transit trips.

4. Cost Inputs and Assumptions

Travel cost is one of the major factors determining the mode of transportation for a trip. ARB staff reviewed basic travel cost components such as auto operating cost and value of time that were used as inputs in the Fresno COG TDM. Sensitivity tests, such as those for auto operating cost, and transit frequency were also evaluated to examine the responsiveness of the Fresno COG TDM to changes in the cost variable or other model inputs. The results of the sensitivity tests are presented in the model sensitivity analysis section of this report.

Auto Operating Cost

Auto operating cost is a key parameter used in the mode choice step of the travel model. Fresno COG staff defined auto operating costs to include the cost of fuel, vehicle maintenance, and tire replacement. The assumed year 2008 auto operating cost in the Fresno COG travel demand model expressed in year 2000 dollars is 21.6 cents per mile.

Fuel price is an important factor that influences per capita VMT. The price of fuel is the amount consumers pay at the pump for regular grade gasoline (in dollars/gallon). When gasoline prices go up, drivers are expected to decrease their frequency of driving, reduce their travel distance, increase their use of public transit, and/or switch to more fuel efficient cars. Lower gas prices would be expected to have the opposite effects on VMT.

Fresno COG staff forecasted fuel prices using the same methodology used by the other major California MPOs. Fresno COG staff used the high and low gasoline price forecasts from the United States Department of Energy's (USDOE) "Energy Outlook with Projections to 2035," starting with 75 percent of the difference between the high value and the low value, then added this to the low value, and then added $0.25 to account for the higher cost of gasoline in California, relative to the national average. Forecasted gasoline prices for the years 2008, 2020 and 2035 are summarized in Table 8: Fuel Price (in Year 2009 dollars). ARB staff compared Fresno COG's travel model forecasted gasoline prices for year 2020 and year 2035 with major California MPOs' forecasts. Fresno COG's estimates are consistent with major MPOs' fuel price forecasts for year 2020 and year 2035.

Table 8: Fuel Price (in Year 2009 dollars)

Year	Fresno ($/gal)	Difference from Baseline (%)
2008	4.00	0%
2020	4.74	19%
2035	5.24	31%

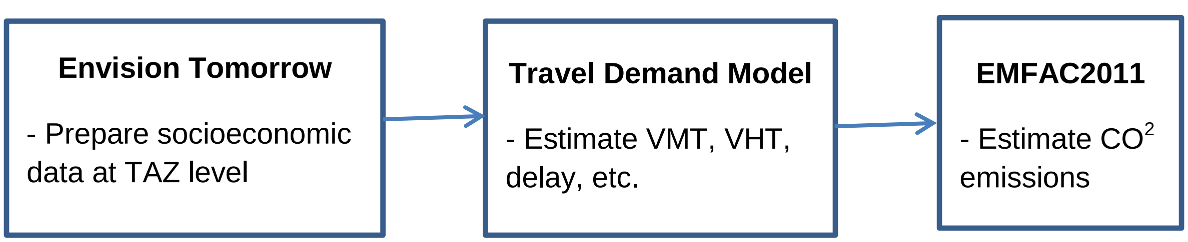
Cost of Time

Fresno COG staff converted travel cost to cost of time using a value of time. The average perceived value of time that Fresno COG estimated was six dollars per hour per person. The value of time was also further adjusted according to vehicle ownership status.

C. Modeling Tools

Fresno COG used a land use scenario planning tool (i.e. Envision Tomorrow), a trip-based travel demand model, and the ARB vehicle emission model (i.e. EMFAC2011) to complete the analysis of GHG estimations for its 2014 RTP/SCS. The analysis years for the GHG emissions were 2005, 2020, and 2035. Figure 6 shows the flow chart of the modeling process. The land use tool takes demographic data and forecasts as inputs, and then allocates growth in housing, employment and population at transportation analysis zone (TAZ) level. The outputs of the land use model were fed as inputs to the TDM to estimate amount of travel. Results from the TDM, such as VMT by time of day, were input to EMFAC2011 to estimate GHG emissions associated with the 2014 RTP/SCS. Fresno COG also incorporated off-model adjustments to account for changes in GHG emissions and other model outputs where it was known that their TDM was not responsive, or was insufficiently sensitive, to certain strategies in their SCS.

Figure 6: Fresno COG's Modeling Tools



1. Land Use Model

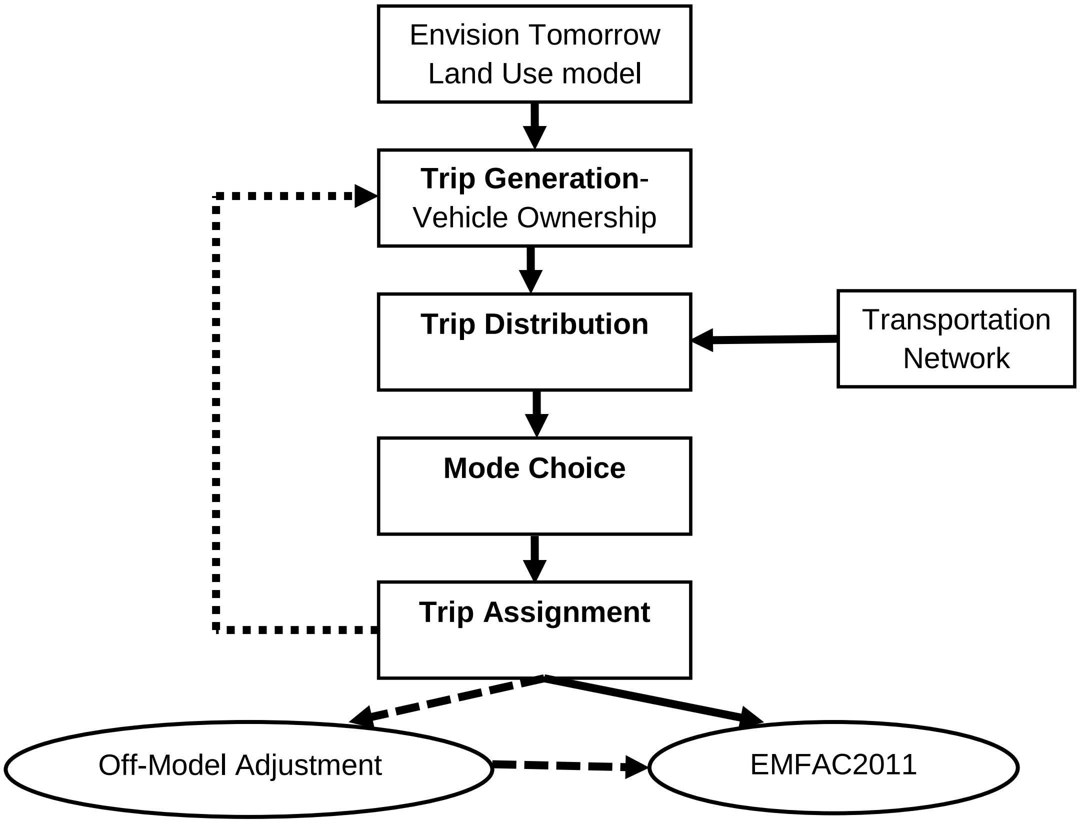
Envision Tomorrow, discussed above in Section III. B., Current and Future Land Use, was used to develop and compare alternative land use scenarios for the 2014 RTP/SCS. For each planning scenario, Fresno COG used Envision Tomorrow to allocate the projected number and types of housing and employment at the parcel- or grid-level within specific planning areas. Land use modeling results and calculation elements associated with a scenario are stored in look-up tables and GIS-map based files. Different land use scenarios based on different policies were then developed for evaluation and comparison purposes. The spreadsheet formatted outputs associated with Fresno COG's preferred scenario served as inputs to the TDM.

2. Travel Demand Model

In 2010, the eight MPOs in the SJV began a collaborative process to improve their travel demand modeling capabilities. This process, known as the San Joaquin Valley Model Improvement Plan (MIP) was funded by SGC and concluded in 2012. The MIP effort substantially upgraded and standardized travel demand models of Valley MPOs and their improved on their ability to evaluate land use and transportation strategies pertinent to meeting SB375 requirements. This is the first RTP to be developed using the new MIP model.

The upgraded Fresno COG TDM is a Cube platform-based model that estimates travel demand and traffic and transit volumes for the average weekday. The model area covers all of Fresno County and its 15 cities. The model divides the region into approximately 2,900 TAZs representing land use within the region and 30 gateway zones which represent major road crossings of the county line for interregional trips Figure 7 shows the components of the Fresno COG travel demand model.

Figure 7: Fresno COG's Regional Travel Demand Model



a) Vehicle Ownership

Modeling of vehicle ownership is a new component of the Fresno COG's TDM. Previously Fresno COG used a fixed rate of vehicle ownership. The new model calculates the number of motor vehicles in the Fresno region based on demographic characteristics, auto operating cost, and accessibility, which helps to capture the economic characteristics of each household. The output of this component is a critical input to the trip generation step.

ARB staff evaluated the structure and variables used in the vehicle ownership model, as well as whether the model followed the state of the practice.11 The model captures the relationship between household characteristics and vehicle ownership, and shows that the number of vehicles available per household increases as the average household income rises. This is consistent with the recommended practice in the Federal Highway

[11] The state of the practice indicates the methods used by most MPOs in developing their travel demand models.

Administration's "Model Validation and Reasonableness Checking Manual." (FHWA 2010). For future model improvements, Fresno COG can consider including the sensitivity to land use and transit accessibility in modeling auto ownership, as well as to validate the vehicle ownership model results against the Department of Motor Vehicles' (DMV) data.

b) Trip Generation

The trip generation component of the Fresno COG's TDM estimates the number of person-trips for each activity, such as traveling to-and-from work, school, shops, and social/recreational events. The new model estimates person trips based on trip generation rates using a cross-classification model. A cross-classification model is similar to a look-up table, and develops average household trip rates by purpose, based on household demographics. The variables used in the trip production model are housing type, household size and income. The trip generation rates for the Fresno COG TDM were based on the 2000/2001 California Household Travel Survey (CHTS) and previously developed models. Fresno COG staff used survey results from four SJV counties (i.e. Fresno, Kern, Kings and Tulare) to ensure an appropriate sample size for trip generation rates estimation. There are eleven trip purposes included in the trip generation step – home-based work (HBW), home-based shop (HBShop), home-based K12 (HBK12), home-based college (HBCollege), home-based other (HBO), work-based other (WBO), other-based other (OBO), highway commercial, trucks-small, trucks-medium, and trucks-large.

Trip ends were classified as either trip end production[12] or trip end attractions[13]. The trip attraction rates for HBW were derived from the 2000/2001 CHTS. Fresno COG calculated the average number of HBW commute trips for each type of employment from survey data. The OBO trip production and attraction rates for each employment type were estimated by comparing the trip generation derived from the 2000/2001 CHTS to standard vehicle trips in the ITE Trip Generation manual.

The modeled person trip rates were then converted to vehicle trips using average auto occupancies in the Fresno COG region (i.e. drive alone, shared ride 2, shared ride

[12] Trip production is defined as the home end of any home-based trip, regardless of whether the trip is directed to or from home. If neither end of the trip is a home, it is defined as the origin end.

[13] Trip attraction is defined as the non-home end of a home-based trip. If neither end of the trip is a home, the trip attraction is defined as the destination end.

3+[14]). Fresno COG also included trip rates for recreational activities such as parks and golf course based on the ITE Trip Generation manual. Table 9 summarizes the estimated trip productions and attractions. The percent difference between trip productions and attractions is acceptable because it is within 10 percent difference stated in the 2010 FHWA's Travel Model Validation and Reasonableness Checking Manual.

Table 9: Balanced Household Trip Productions and Attractions

Trip Purpose	Productions	Attractions	Percent Difference	FHWA Criterion
HBW	484,919	467,649	-3.6%	±10%
HBShop	276,845	290,934	5.1%	±10%
HBO	1,018,477	1,007,823	-1.0%	±10%
NHB[15]	572,150	561,126	-1.9%	±10%

As part of the evaluation of the trip generation step, ARB staff reviewed the parameters used in the trip production and attraction models, their association to trip rates, and the responsiveness of trip rates to key parameters in the model.

The analysis of Fresno COG's trip generation component of the model indicates that trip rates tend to increase as household income and household size increases. Overall, Fresno COG's trip generation model followed the process for estimating trip generation outlined in NCHRP Report 365. As part of future model improvement, Fresno COG can include some sensitivity to land-use mix, particularly in areas with high transit use to capture the transit oriented development travel behavior. Fresno COG can also consider using the latest available independent data sources such as the National Household Travel Survey (NHTS), Census Transportation Planning Package (CTPP),and the American Community Survey (ACS) to validate the travel model.

[14] Shared ride 3+ includes vehicles with 3 or more riders including driver in the vehicle, calculated as is 3.5 persons per vehicle.

[15] Non home-based trips.

c) *Trip Distribution*

The trip distribution step used a gravity model to estimate the number of trips from one zone to any other zone. The inputs to the gravity model[16] include the person trip productions and attractions for each zone, zone-to-zone travel time and travel cost, and friction factors[17] that define the effect of travel time. The travel time (or skim) between a pair of zones is based on the shortest path connecting the two zones. The results of the zone-to-zone travel times serve as input to the trip distribution process. Intrazonal travel times were assumed to be 100 percent of the average travel time to the nearest adjacent urban TAZ and one-third the average travel time to the nearest adjacent rural TAZ.

Because time is an important factor in trip distribution, Fresno COG defined terminal times as the average time to access one's vehicle at the each end of the trip. Table 10 summarizes the assumptions for terminal times.

Table 10: Terminal Time Assumptions

Trip Type/Location	Terminal Time (minutes)
Home (production)	1
Non-home (attraction)	2
Fresno Central Business District (CBD)	4
Colleges and universities within the urban area	3

In evaluating the trip distribution step of Fresno COG's travel demand model the average trip length by time, distribution of trips by purpose, and the number of intra-zonal trips were reviewed. Table 11 shows the average trip lengths by trip purpose from the model. The differences between the modeled travel time and the observed travel time (CHTS) are expected due to the limited samples from the 2000/2001 CHTS

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[16] A gravity model assumes that urban places will attract travel in direct proportion to their size in terms of population and employment, and in inverse proportion to travel distance.

[17] Friction factors represent the effect that travel time exerts on the propensity for making a trip to a given zone.

for Fresno COG region, the time gap between model base year (i.e. 2008) and survey year, and also due to the different survey information collection locations in California which could vary from the Fresno COG demographic make-up.

Table 11: Average Travel Time by Trip Purpose (minutes)

HBW		HBO		NHB	
CHTS	Model	CHTS	Model	CHTS	Model
20.2	16.4	15.1	20.6	15.5	16.1

Source: Fehr & Peers 2014

Fresno COG estimated the friction factors, which reflect the effect that travel time/cost on a trip from an origin zone to a destination zone, based on the methodology documented in the NCHRP Report 365. Resulting trip lengths were compared to those reported in the 2001 CHTS. The friction factors were then adjusted so that the model trip length can better match observed data. Table 12 summarizes the results of trip distribution by trip purpose by trip type. Trips that begin and end in the region (Internal-Internal, or II trips) follow the observed data reasonably well with less than 15 percent difference (Table 12). The number of modeled Internal- External (IX) and External-Internal (XI) trips did not match reasonably well due to lack of data from the CHTS specific to the Fresno region. Without locally specific data, Fresno COG used the friction factors from the NHCRP Report 365 which are based on national case studies.

Table 12: Trip Distribution by Purpose

Trip Type	Total		HBW		HBO		NHB	
	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model
II	88.2%	95.7%	83%	83.1%	91.1%	99.4%	86.8%	98%
IX	5.8%	0.9%	9%	2.2%	4.5%	0.3%	5.7%	1%
XI	6.0%	3.4%	8%	14.6%	4.4%	0.3%	7.5%	1%

Source: Fehr & Peers 2014

To better estimate the GHG reductions associated with SCS strategies in the future, ARB staff recommends that Fresno COG consider developing a destination choice model which can improve the sensitivity of changes to land use and socioeconomic factors on trip distribution by better reflecting the attributes that influence a person's decision to travel. Also Fresno COG should provide goodness-of-fit statistics in future model documentation and the frequency distribution of trip lengths along with coincidence ratios for different trip types to evaluate the travel model.

To allow for evaluation of the overall performance in the trip distribution step, ARB staff recommends that Fresno COG provide goodness-of-fit statistics in future model documentation. In the future, Fresno COG should also provide the frequency distribution of trip lengths along with coincidence ratios for different trip types to evaluate the travel model.

d) Mode Choice

The mode choice step uses the output from the trip distribution step arranged by purpose and assigns trips to different modes based on available transportation modes, travel time, travel cost, and socioeconomic characteristics. Fresno COG used a multinomial logit model[18] to assign the person-trips to various modes of travel between each pair of zones, including: drive-alone or shared ride passenger auto (i.e. shared ride 2, shared ride 3+), walk to transit (TW), drive to transit (TD), walk or bike modes.

Fresno COG staff used the 2000/2001 CHTS survey data and the annual ridership by route on Fresno Area Express (FAX) transit and Clovis Transit from July 2007 to June 2008 as inputs to model transit ridership.

[18] A multinomial logit model assigns the probability of using a particular mode based on an attractiveness measure or utility for an alternative model in relation to the sum of the attractiveness measures for all modes.

Table 13 summarizes the mode share results from the model. Mode share estimates were compared against the observed data from CHTS, and the differences were less than 4 percent by mode.

Table 13: Percent Mode Share Results

Mode	Model	Survey
DA	38.3%	41.7%
SR2	27.3%	26.5%
SR3+	26.1%	24.3%
Transit	1.6%	1.1%
Walk	5.0%	5.8%
Bike	1.7%	0.6%
Total	**100.0%**	**100.0%**

Source: Fehr & Peers 2014

Table 14 summarizes the mode outputs of transit ridership. The model estimates are about 10 percent higher than reported data from the transit operator. This difference is within the evaluation criterion of 20 percent difference that Fresno COG chose. FHWA does not provide a reasonable range for transit ridership validation.

Table 14: Transit Ridership Estimates for 2008

Transit Operator	Model	Survey	Percent Difference
FAX	40,806	37,094	10.0%
Clovis Transit	811	737	10.0%
Total	**41,617**	**37,831**	10.0%

In evaluating the mode choice step of Fresno COG's travel demand model, ARB staff reviewed the model structure, and data and data source that Fresno COG used to develop and calibrate the model, model parameters, and auto-occupancy rates[19] by purpose. Estimated mode share by trip purpose was also compared against the observed data, including transit ridership.

[19] Auto-occupancy indicates the number of people including driver in a vehicle at a given time.

The method Fresno COG used to develop its mode choice model is consistent with the approaches used nationwide as cited in NCHRP Report 365. However, the coefficients and constants used in the mode choice model are based on the other regional models.

In future model updates, Fresno COG should consider developing a nested logit based mode choice model since they have more than two mode choices. The mode choice model should include demographic and socioeconomic characteristics in allocating the trips between modes. Model documentation should also include more details on the model estimation process, estimated parameters, and statistical significance of the estimates. Fresno COG should consider auto occupancy rates by trip purpose in its mode choice step, and use the latest household travel survey data.

e) Trip Assignment

The final step in Fresno COG's model is trip assignment. This step consists of separate highway and transit assignments. The trip assignment step assigns vehicle trips or transit trips from one zone to another to specific routes on the transportation network. This process utilizes a user equilibrium assignment concept to assign vehicles to roadway in the network. The iteration runs until no driver can shift to an alternative route with a faster travel time. The convergence criteria used in the Fresno COG model is 0.001 relative gap[20], or a maximum internal iteration of 50. The travel model used the Bureau of Public Roads (BRP) formula to estimate congested travel time, which is a common practice among transportation planning agencies.

For transit trip assignment, the best path was chosen based on in-vehicle time plus weighted out-of-vehicle times. Transit trips were assigned in four groups: peak period, walk access; peak period, drive access; off-peak, walk access; and off-peak, drive access.

The travel model also includes a feedback loop that inputs congested travel time into the trip distribution step, to account for travelers who change their travel routes and modes in response to changed travel times. The iteration runs until the congested speeds and traffic volumes do not vary significantly between two consecutive iterations.

In evaluating the trip assignment step, ARB staff reviewed the assignment function used in the model and estimated and observed volume counts by facility type. ARB staff also compared these estimated volume counts by facility type with observed data in the region. The travel model uses an assignment function as required by CTC's "2010

[20] Relative gap measures the relative difference of traffic flow between current iteration and the previous iterations.

California RTP Guidelines” to estimate the link volumes and speeds. The coefficients used in the assignment function were consistent with FHWA guidelines. A comparison of estimated and observed traffic counts at the screenline[21] locations by facility type (Table 15) shows that all the facility types fall within the acceptable range of FHWA guidelines. Further, the observed and modeled volume counts at screenline locations had a strong correlation of 0.91, indicating that the model closely followed the observed data.

Table 15: Comparison of Estimated and Observed Traffic Counts

Facility type	Model	Observed	Difference (%)	FHWA Guidelines (%)
Freeway	1263585	1,210,764	4	±7
Highway	648,906	653,527	-1	±10
Expressway	994,077	887,317	12	±15
Arterial	4,377,231	4,414,422	-1	±10
Freeway Ramp	5,394	4,578	-18	±20
Collector and local	969,523	1,105,776	-12	±20

The estimated VMT from the model and the observed data from the Caltrans Highway Performance Monitoring System (HPMS)[22] were compared at the county level (Table 16: VMT Estimate in 2008) and differences were less than one percent.

Table 16: VMT Estimate in 2008

	Model	HPMS	Difference (%)
VMT in 2008	22,148,975	22,376,000	1%

[21] The screenline is an imaginary line used to split the study area into different parts. Along these lines, traffic counts are collected to compare against the model estimates.

[22] Highway Performance Monitoring System is a federally mandated program to collect roadway usage statistics for essentially all public roads in the US.

f) Model Validation

Model validation, usually the last step in the development of any regional TDM, reflects how well model estimates match with observed data. The CTC Regional Transportation Guidelines suggests validation for a travel model should include both static and dynamic tests. The static validation tests compare the model's base year traffic volume estimates to traffic counts using the statistical measures and the threshold criteria (Table 17). Testing the predictive capabilities of the model is called dynamic validation and it is tested by changing the input data for future year forecasts. Fresno COG conducted model sensitivity tests as part of their model dynamic testing, which is summarized and discussed later in this report. Fresno COG's model validation was based on a traffic count database, the Caltrans Performance Measurement System (PeMS), and HPMS.

Based on the results presented in Table 17, Fresno COG's travel model has a correlation coefficient of 0.91 between the modeled and the observed volumes. The root mean square error (RMSE) for daily traffic assignment in the model is 36 percent. However, only 60 percent of the links with volume-to-count ratios from the Fresno COG travel demand model are within the Caltrans deviation allowance. Fresno COG staff explained that this might be due to aggregation of traffic count data from 2001 to 2012. Further, the variations in methods used to collect data and the geographical locations of data collection may have contributed to this difference.

Table 17: Static Validation According to CTC's Guidelines

Validation Item	Criteria for Acceptance	Fresno COG's Model
Correlation coefficient	at least 0.88	0.91
Percent RMSE[23]	below 40%	36%
Percent of links with volume-to-count ratios within Caltrans deviation allowance	at least 75%	60%

3. EMFAC Model

ARB's Emission Factor model (EMFAC2011) is a California-specific computer model which calculates weekday emissions of air pollutants from all on-road motor vehicles including passenger cars, trucks, and buses for calendar years 1990 to 2035.

[23] RMSE measures average error between observed and modeled traffic volumes on links.

The model estimates exhaust and evaporative hydrocarbons, carbon monoxide, oxides of nitrogen, particulate matter, oxides of sulfur, methane, and CO_2 emissions. It uses vehicle activity provided by regional transportation planning agencies, and emission rates developed from testing of in-use vehicles. The model estimates emissions at the statewide, county, air district, and air basin levels.

The EMFAC2011 modeling package contains three components: EMFAC2011-LDV for light-duty vehicles, EMFAC2011-HD for heavy-duty vehicles, and EMFAC2011-SG for future growth scenarios. EMFAC2011-SG uses the inventory from EMFAC2011-LDV and EMFAC2011-HD modules and scales the emissions based on changes in total VMT, VMT distribution by vehicle class, and speed distribution. To estimate per capita CO_2 emissions, Fresno COG estimated passenger vehicle VMT and speed profiles for the region using the travel demand model and applied them to the EMFAC2011-SG model. Fresno COG then divided the estimated CO_2 emissions for passenger vehicles by the year 2005, 2020, and 2035 residential populations to obtain CO_2 emissions per capita.

4. Off- Model Adjustments

Fresno COG made off-model adjustments to estimate GHG emissions reductions from strategies to which its travel model and land use model are not sensitive. These off-model adjustments are based on evidence from studies and research which demonstrate the potential for GHG emissions reductions from several SCS strategies, including ride-sharing (i.e. carpool, vanpool), employer-based commute strategies, enhancement of bicycle and walk facilities, and Intelligent Transportation System (ITS) deployment.

a) Ride-Sharing

Fresno COG is a member of the California Vanpool Authority (CalVans). CalVans reported in 2012 that vanpools accounted for a reduction of 51,424,724 miles in the region, which is translates to 197,787miles daily. Fresno COG assumes this level of reduction in total VMT of approximately 1.03 percent will remain steady in the future for 2020 and 2035, and therefore applied the same amount of VMT reduction to its adopted SCS.

b) Employer-Based Commute Strategies

The SJVAPCD adopted Rule 9410: Employer Based Trip Reduction to require larger employers to establish an Employer Trip Reduction Implementation Plan (eTRIP) to encourage employees to reduce SOV trips. Rule 9410 applies to approximately 1,883 worksites including 500,000 commuting employees throughout the SJV. Rule 9410 distinguishes these worksites into two tiers: Tier One worksites are those with 100 to 249 eligible employees and Tier Two worksites are those with 250 or more eligible employees. It is estimated there are 1,342 Tier One worksites and 541 Tier Two worksites in the SJV. Fresno COG staff assumed that its region is home to 25 percent of these worksites because it has about 25 percent of the SJV population.

Fresno COG staff estimated the VMT reduction from commute trips based on modeled average HBW trip length, number of worksites in the region, and the average number of employees per worksite by tier. Fresno COG estimated a 1.37 percent reduction in total VMT by 2020 and a 1.16 percent reduction in total VMT by 2035 with the deployment of this strategy.

c) Bicycle and Walk Facility Enhancement and ITS Deployment

Besides the continued deployment of ride-sharing and employer-based commute strategies in reducing total VMT in the region, Fresno COG also proposed reductions through bicycle and walk facility enhancement and ITS strategies. Fresno COG estimated these reductions based on the middle level deployment scenario summarized in the Moving Cooler report by Cambridge Systematics. Fresno COG used the 2020 GHG reductions listed in the Moving Cooler report for year 2020 and the 2030 GHG reductions in the report for its 2035 reduction assumptions for these strategies. Table 18 summarizes the GHG reduction credits Fresno COG uses. The assumptions Fresno COG made are consistent with the recommendations in the Moving Cool report. The bike/walk facility enhancement and ITS deployment strategies are expected to contribute 7.6 MMT and 8.6 MMT GHG emission reductions by 2020 and 2035, respectively.

Table 18: GHG Reductions from Bike/Walk Facility and ITS Strategies

Strategy Description	GHG Reductions in Million Metric Tons (MMT)			
	2020		2035	
	Fresno COG	Moving Cooler	Fresno COG	Moving Cooler
Combined pedestrian	5	5	5	5
Combined bicycle	1	1	2	2
Ramp metering	0.4	<0.5	0.4	<0.5
Variable message signs	0.4	<0.5	0.4	<0.5
Signal control management	0.4	<0.5	0.4	<0.5
Traveler information	0.4	<0.5	0.4	<0.5
TOTAL	**7.6**	**--**	**8.6**	**--**

Overall GHG Emissions Reduction from Off-Model Strategies

Fresno COG included strategies such as ride-sharing, employer-based commute strategies, bike/walk facility enhancement, and ITS deployment as its off-model adjustments, the assumptions associated with these strategies were based on observed local data of existing programs (e.g. CalVans, Rule 9410) and national level GHG emission reductions recommended in the Moving Cool report. Overall, these off-model strategies contribute to a 2.7 percent reduction in VMT in the Fresno COG region in 2020 and 2035, which is translates to an approximately 2.7 percent reduction in GHG emissions in 2020 and 2035.

5. Planned Model Improvements

For the next RTP update anticipated in 2018, Fresno COG plans to continue to refine its travel demand model to better estimate trips and VMT in the region. The immediate and ongoing model improvement efforts include using the latest regional or local demographic data and using the latest CHTS travel data for model recalibration and revalidation. Immediate model improvements seek to increase model sensitivity to land use and transportation policies. These model improvements will increase the accuracy of estimates and forecasts of external trips, trip modes and distribution for internal and inter-regional travels; and vehicle speeds (which is critical for air quality analysis).

In addition, Fresno COG has planned a series of longer-term actions to improve its travel model and has allocated $150,000 for these improvements before adoption of its 2018 RTP. The additional improvements to Fresno's model will be built on the outcomes from the valley wide improvements. Fresno COG is planning to enhance the model's TAZ structure to more accurately model travel movements of transit oriented development, and is planning to move to an activity-based model which will enhance the quality of analytical tools available to regional decision makers in the long-run.

While the current travel model is able to forecast trips and VMT reasonably well, ARB staff offers suggestions for to improve the model's forecasting ability in Sections III. B. and C.—Data Inputs and Assumptions and Modeling Tools. These suggestions should be incorporated into the model improvement program that Fresno COG is currently developing.

D. Model Sensitivity Analysis

Sensitivity analysis tests the responsiveness of the travel demand model to changes in selected input variables. The responsiveness, or sensitivity, of the model to changes in key inputs indicates whether the model can reasonably estimate the anticipated change in VMT and associated GHG emissions resulting from the policies in the SCS. This analysis usually assumes one input variable change at a time and examines the range of output change. Sensitivity analyses are not intended to quantify model inputs or outputs or provide analyses of actual modeled data. Following the methodology in ARB's "Description of Methodology for ARB Staff Review of Greenhouse Gas Reductions from Sustainable Communities Strategies (SCS) Pursuant to SB 375" (2011) ARB staff reviewed results from model test runs on land use, transit, and pricing variables.

Model sensitivity test results were compared to findings in empirical literature in order to evaluate the model's ability, given the data inputs and assumptions, to produce reasonable forecasts. In those instances where the findings were corroborated by the empirical literature, the findings were referred to as either sensitive directionally, meaning that the direction of change was consistent with findings in the empirical literature, or sensitive in magnitude, meaning that the amount of change predicted was consistent with the literature.

In those cases where sensitivity analysis findings could not be specifically corroborated by the empirical literature, ARB staff indicated whether the model was sensitive, meaning that changes in model inputs resulted in reasonable changes to model outputs. ARB staff assisted Fresno COG in conducting tests on auto operating cost, transit frequency, household income distribution, and change in land use. Either Fresno COG staff or ARB staff, as indicated, provides the sensitivity test methodology and results presented in this section.

1. Auto Operating Cost

Fresno COG used three scenarios to examine the responsiveness of the model to changes in auto operating cost. Auto operating cost is an important factor influencing travelers' auto use. Fresno COG's definition of auto operating cost for the region includes fuel price, vehicle maintenance cost, and tire replacement cost. When the auto operating cost increases, travelers are expected to drive less. Conversely, when auto operating cost decreases, travelers are expected to drive more. In relation to mode share, it is expected that as auto operating cost increases, the number of drive-alone trips would shift to high occupancy vehicles (HOV), transit and walking.

Figure 8: Mode Share Split and Auto Operating Cost (AOC)

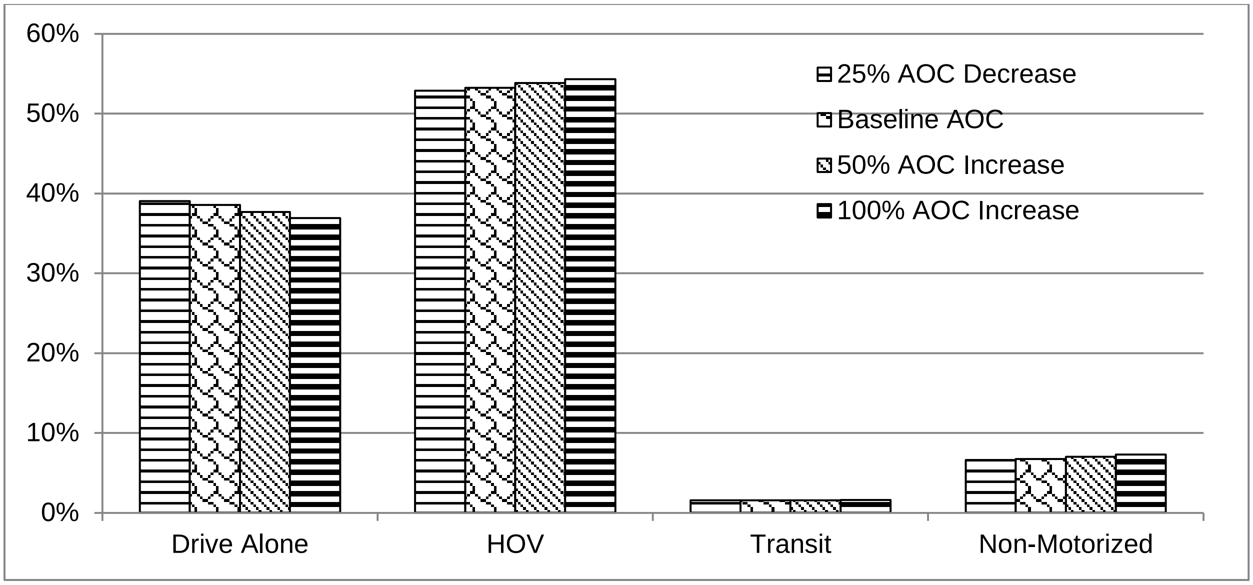


Figure 8 shows the shift in mode share distribution with a 25 percent decrease, 50 percent increase and 100 percent increase in auto operating cost. The trend is consistent with expectations in that as the auto operating cost increases, the percentage of drive alone (SOV) trips decreases while other modes such as HOV, transit and non-motorized trips increase.

Figure 9: VMT Change and Auto Operating Cost

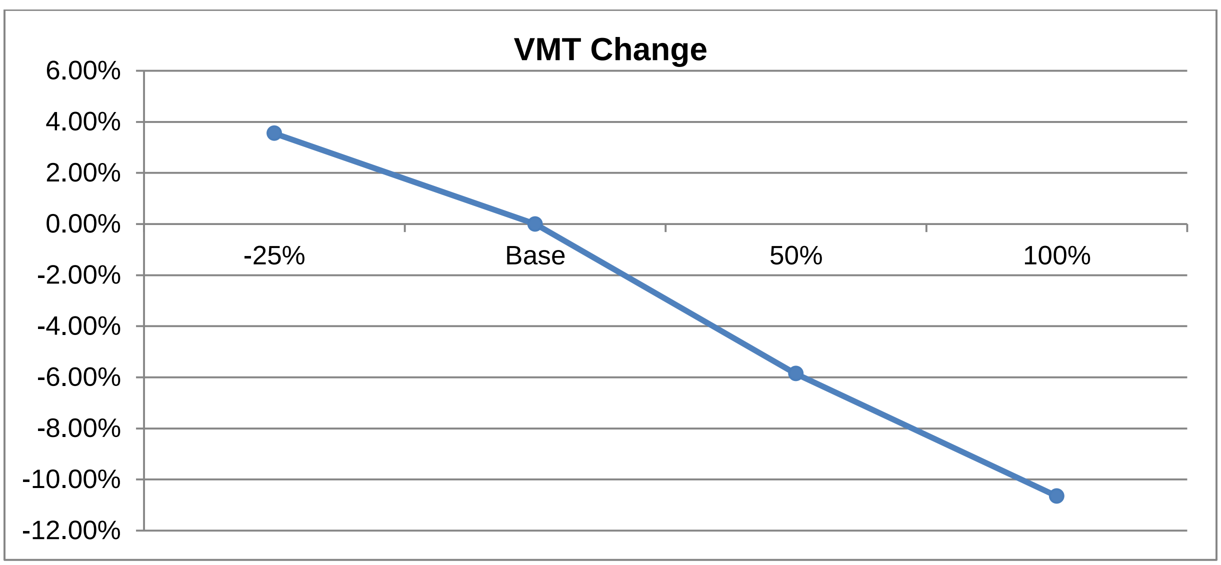


Figure 9 shows the VMT changes related to changes in the auto-operating cost scenarios. As auto operating cost increases, the model shows a decrease in VMT. The percentage of VMT change from the base case in each scenario ranged from -10.65 percent to 3.55 percent.

ARB staff compared these outputs from the sensitivity to auto-operating cost on VMT to findings from empirical literature. Literature review showed that the short-run elasticities (less than five years) of VMT with respect to auto operating cost ranged from -0.02 to -0.09 (Small and Van Dender, 2007), -0.15 (Agras and Chapman, 1999), and -0.23 (Oum et al., 1992). The long-run elasticities (greater than five years) ranged from -0.11 to -0.34 (Small and Van Dender, 2007), -0.32 (Agras and Chapman, 1999), and -0.28 (Oum et al., 1992).

Table 19 summarizes the results of the auto operating cost sensitivity scenarios with comparisons to the ranges from the empirical literature. The modeled VMT for each of the scenarios changed in the expected direction and fell within the expected range. Some possible explanations for the VMT outputs that are outside of the range of empirical literature include differences in the study location, when the studies where performed and the definition of “auto operating cost”.

Table 19: Auto Operating Costs - Sensitivity Results

Test	Modeled VMT (thousands)	Empirical Short-Run VMT Range* (thousands)		Empirical Long-Run VMT Range** (thousands)	
		Min	Max	Min	Max
25 percent decrease from base case cost	22,665	22,236	23,398	22,734	24,007
Base case (2008)	21,888	--	--	--	--
50 percent increase from base case cost	20,606	19,581	21,904	18,364	20,909
100 percent increase from base case cost	19,557	17,037	21,683	14,603	19,692

*Calculated based on short-run elasticities of -0.02 to 0.23.
**Calculated based on long-run elasticities of -0.11 to -0.34.

2. Transit Frequency

Transit service frequency is a key to the effectiveness of regional transit service. To determine the responsiveness of the Fresno COG model to transit frequency, three alternative frequencies were tested: a 50 percent decrease, a 75 percent decrease, and a 100 percent increase from the base case. The model test results shown in Table 20 were compared to expected values based on existing literature which suggests that a one percent increase in frequency results in a 0.5 percent increase in ridership. As transit service becomes more frequent, transit ridership is expected to increase, and conversely, transit ridership is expected to decline with decreasing frequency.

Table 20: Transit Frequency Impact on Ridership

Scenario	Transit Ridership	Expected Ridership
100% Increase	1,505,664	1,716,173
2008 Base	1,144,115	---
50% Decrease	1,098,329	1,070,871
75% Decrease	1,071,707	1,101,211
100% Decrease	928,286	1,086,909

Source: Handy et. al. 2013

Figure 10 shows the changes in transit ridership with respect to transit frequency changes. As the transit frequency decreases, the Fresno model results in lower ridership. The directionality of these changes and the magnitude of impact from transit frequency changes are reasonable and within the range reported in the empirical literature.

Figure 10: Transit Ridership and Transit Frequency

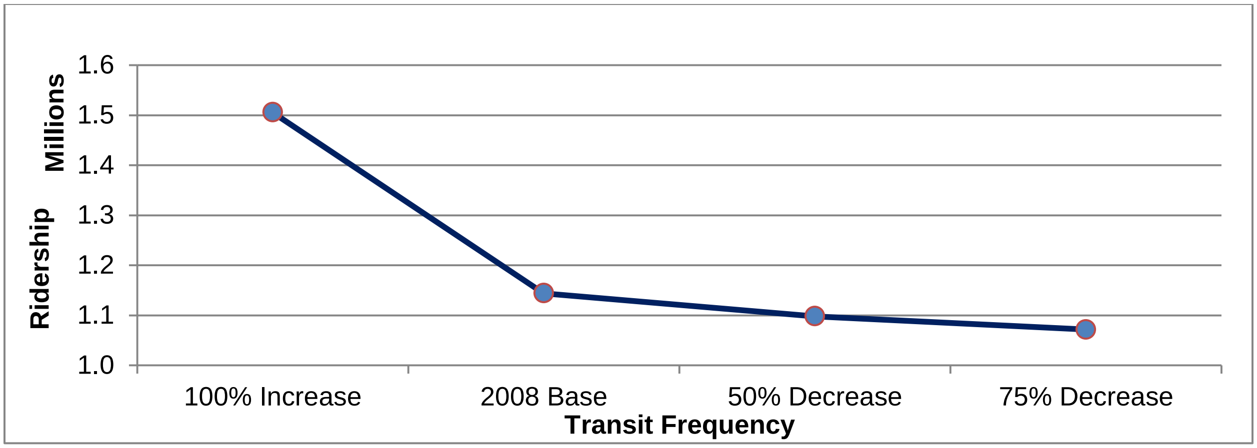
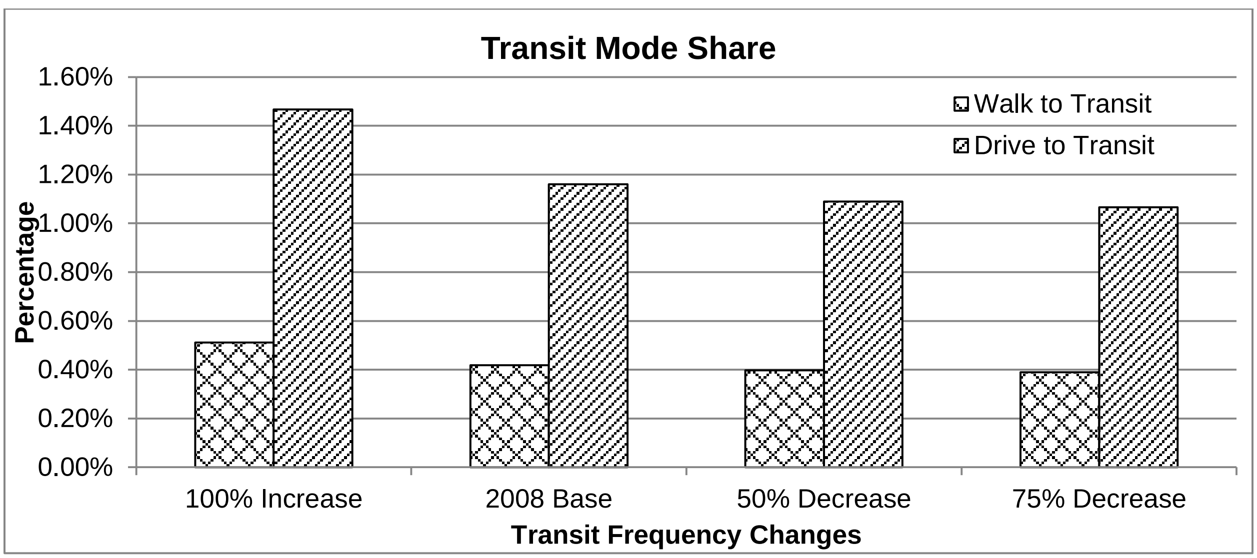


Figure 11 shows the change in transit mode share (walk to transit, drive to transit) as a function of change in transit frequency. With a 100 percent increase in transit frequency, the drive to transit mode share peaks with 1.47 percent of the total trips, whereas the 75 percent decrease in transit frequency results in a drive to transit mode share of 1.07 percent of total trips.

The drive to transit mode share is more sensitive than walk to transit but both show a reasonable responsiveness to increases in transit frequency.

Figure 11: Transit Mode Share and Transit Frequency



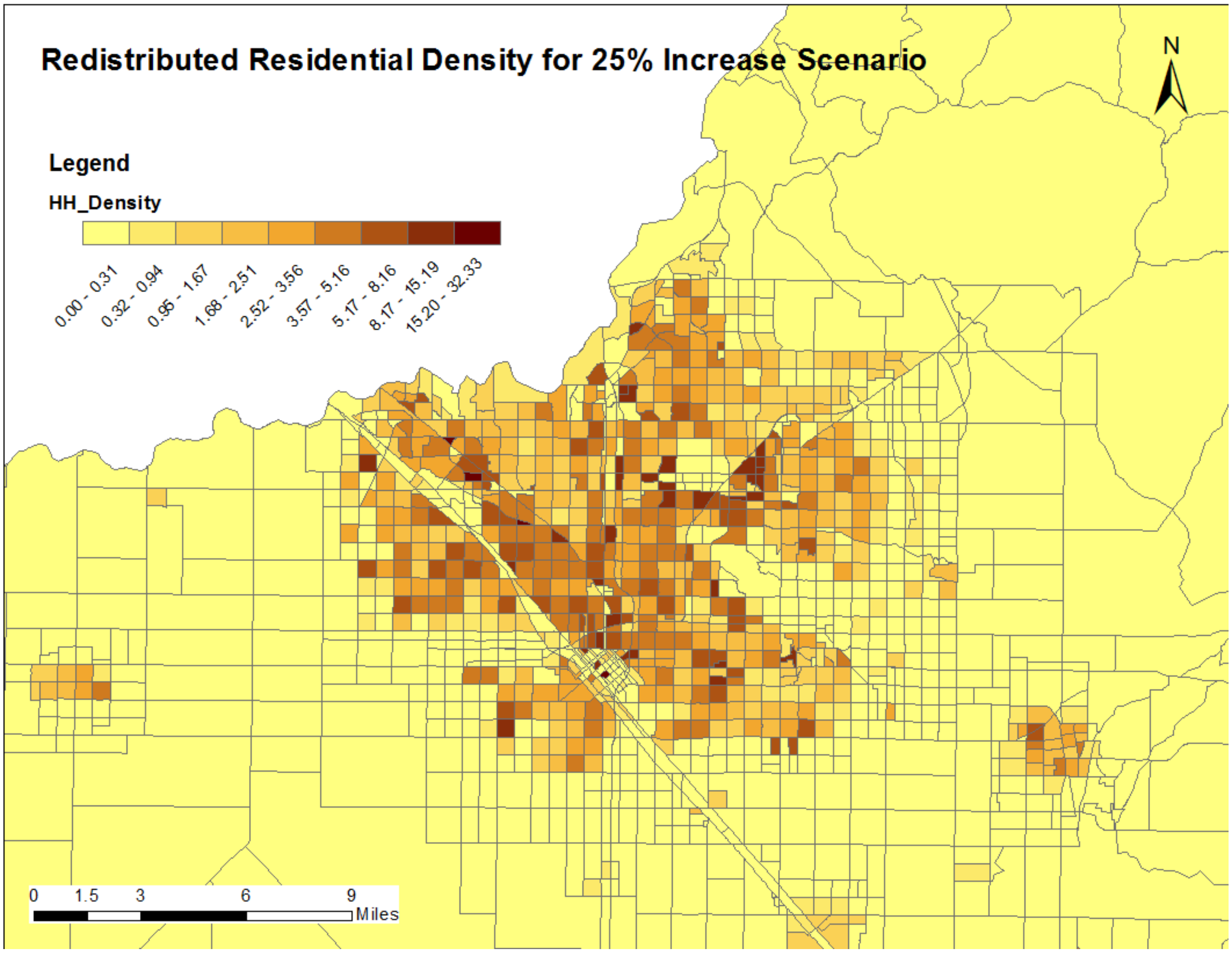
3. Residential Density

Residential density is usually defined as the number of housing units per acre. Increasing residential density has been considered an effective land use strategy to reduce VMT in a region because empirical studies have shown that denser residential developments tends to be associated with less trips and less VMT.

Fresno COG, with assistance from ARB staff, developed a methodology to examine the sensitivity of the travel demand model to change in residential density. The three sensitivity tests involved a 25 percent decrease, 25 percent increase, and 50 percent increase in average residential density. Changes to residential density focused on the urban areas of Fresno County to match the urban area focus of the empirical literature.

For each test, Fresno COG kept the totals for each housing type (e.g. RU1, RU2) the same as the 2008 base case. For the density-increasing scenarios, Fresno COG assumed that TAZs that currently have higher than average residential density would be more likely to gain more housing units than those with a lower than average residential density. Fresno COG incorporated a residential index system to indicate which TAZs have higher and which TAZs have lower than average residential density as compared to the regional average. Figure 12 is an example of redistributed residential density for the 25% increase scenario.

Figure 12: Fresno TDM Residential Density Test- 25% Increase



Source: FCOG 2014c

Figure 13 and Figure 14 show the VMT and mode share changes corresponding to three residential density scenarios. As expected, VMT decreases as residential density increases. While the directionality of the change in mode share is as expected, the magnitude is subtle compared to the change in VMT.

Figure 13: VMT Changes In Response To Change In Residential Density

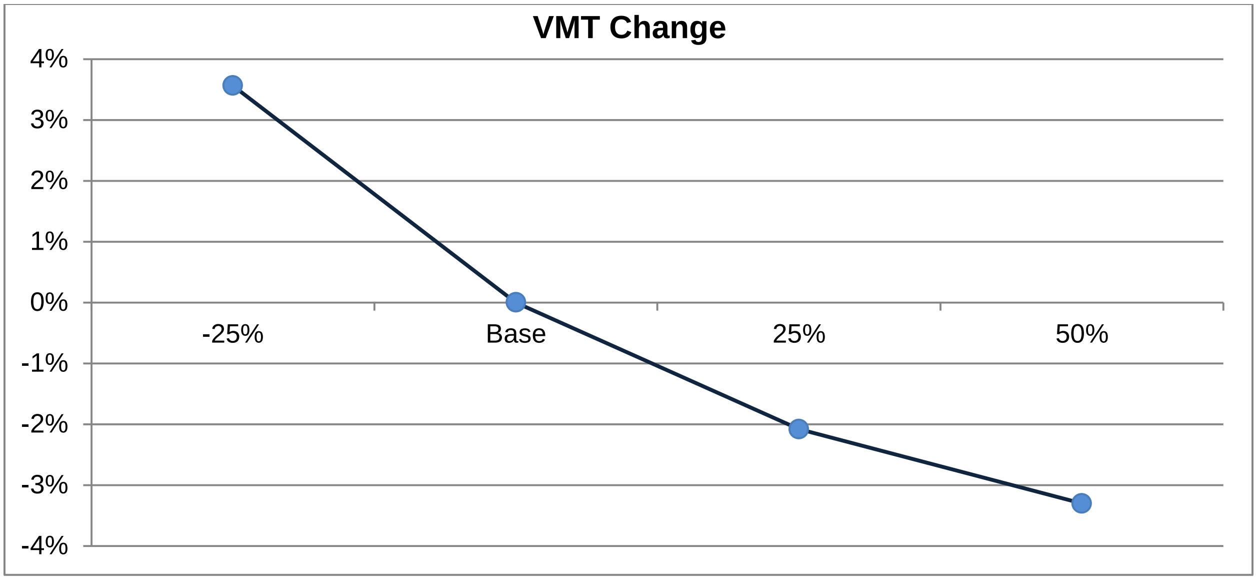


Figure 14: Mode Share Changes In Response To Change In Residential Density

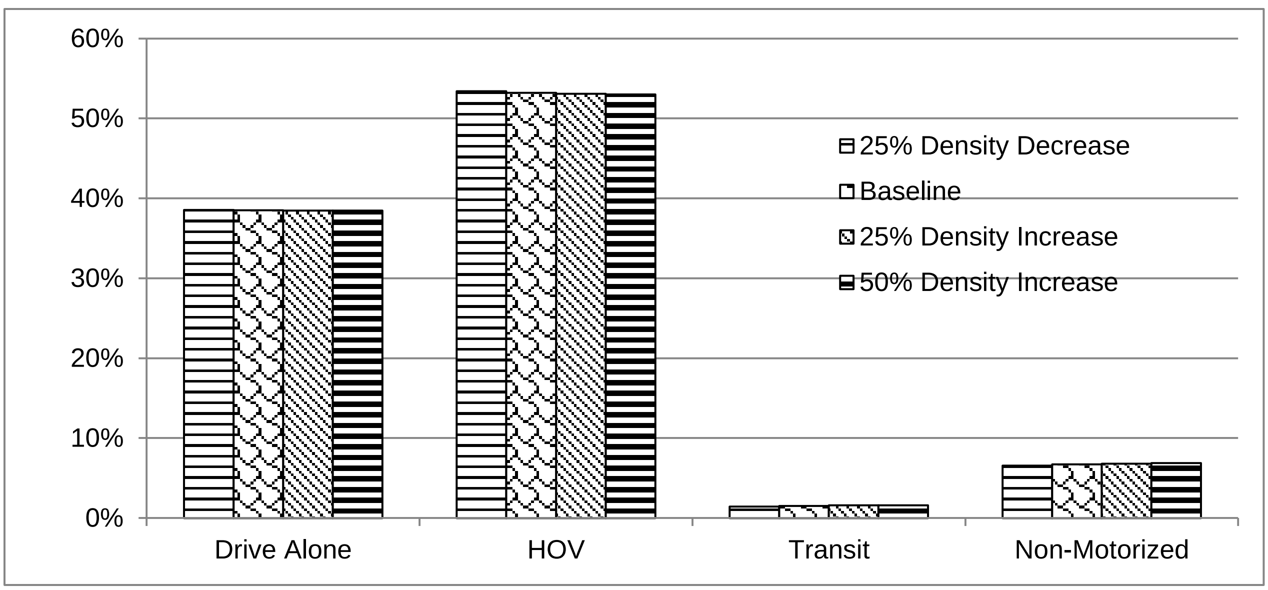


Table 21 shows the range of VMT change expected in response to increases in household density. The results from the sensitivity tests are consistent with the magnitude and directionality of the literature review.

Table 21: Household (HH) Density and VMT

Scenario	Modeled VMT	Expected VMT Low	Expected VMT High
2008 Base	22,125,416		
10 % Mean HH Density Increase	21,960,818	21,697,288	21,851,014
20 % Mean HH Density Increase	21,844,670	21,433,758	21,741,210
50 % Mean HH Density Increase	21,593,699	21,170,229	21,631,406

Source: Boarnet 2014

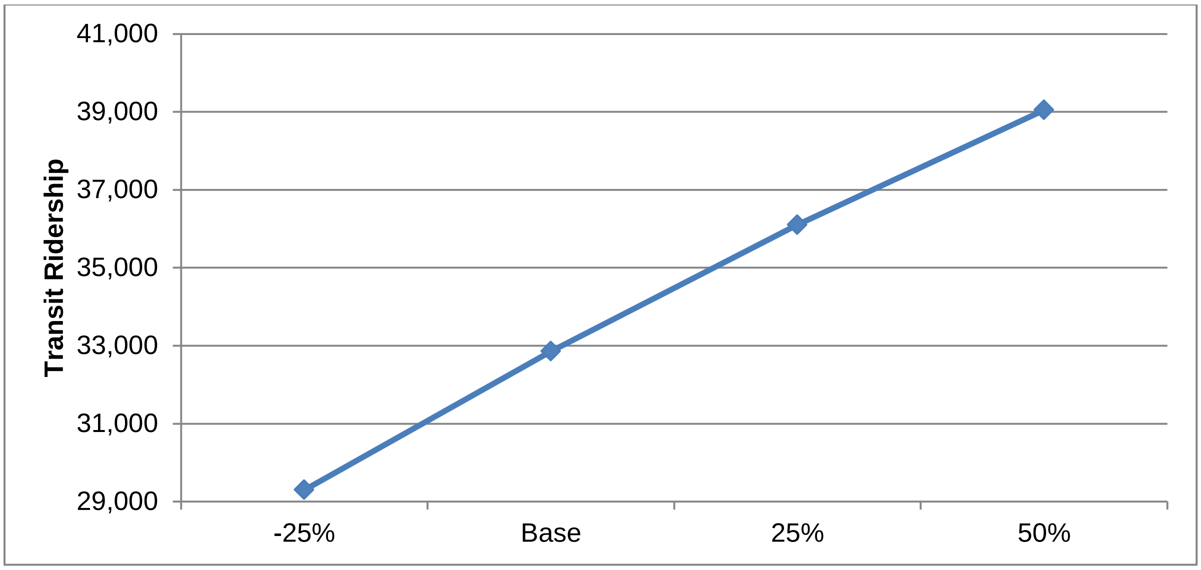
4. Proximity to Transit

The responsiveness of the model to residential proximity to transit was tested by reallocating households to be along existing transit corridors (i.e. transit-oriented development). It is expected that households relocated to transit corridors would be more likely to use transit which would in turn increase transit ridership and decrease household travel cost.

Similar to the residential density test, Fresno COG tested the sensitivity of the model to proximity to transit by placing more or less housing units in TAZs within a half-mile of transit stops. Using the 2008 totals for each housing type as a base case, TAZs within a half-mile of transit line either lost or gained units to represent decreases and increases in density, respectively. The total household counts for each TAZ were adjusted proportionally to maintain their respective countywide totals. The aggregated household total for TAZs near transit was compared against the base household count to calculate the countywide residential housing unit redistribution. As assumed, transit ridership increases as more housing units are located within a half-mile of transit lines.

Figure 15 shows the transit ridership response to changes in proximity to transit. As expected, the ridership increases when the number of residential units near transit increases.

Figure 15: Transit Ridership Changes to Proximity to Transit



5. Household Income Distribution

Household income distribution assumptions play an important role in the trip generation step of the TDM. Household income is linked to the available number of vehicles which then impacts the total number of trips. The expectation of the income distribution sensitivity testing is that as household income increases, so will the proportion of households with a greater number of vehicles. Given the predetermined trip generation rates in the model, if a household has more vehicles, it generates more trips and more VMT. If the income distribution shifts downward, it is expected that the vehicle ownership model will predict more households with fewer available vehicles and similarly, less trips and less VMT.

To test the responsiveness of the Fresno TDM to changes in household income distribution, three testing scenarios were designed and tested using the average household income as an indicator. The 2008 average household income of $52,636 from the Fresno TDM was used as the base case. ARB staff designed three testing scenarios with average household income of Low ($42,100), Medium ($61,721) and High ($66,116). The Fresno vehicle ownership model responded as expected, by increasing the percentage of households with more vehicles as average household income increased.

Figure 16 illustrates how the average vehicle ownership per household changes under the different income scenarios.

The Fresno vehicle ownership model responded as expected, by increasing the percentage of households with more vehicles as average household income increased.

Figure 16: Household Vehicle Ownership Type Distribution

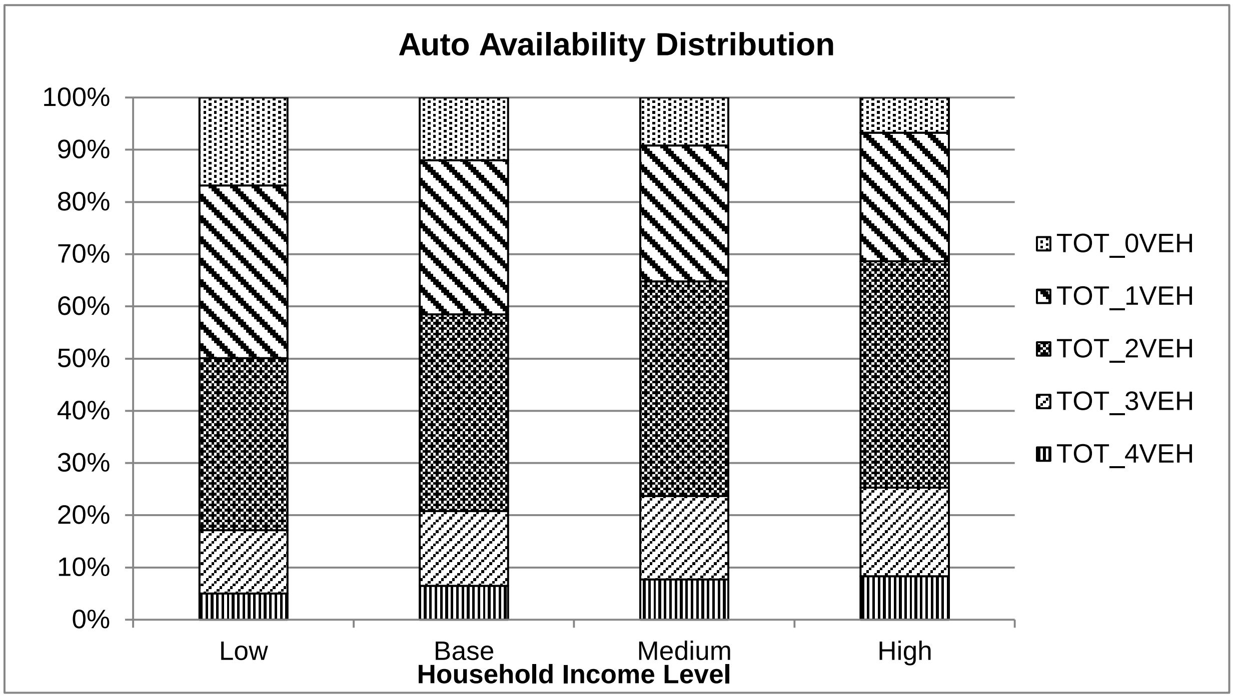
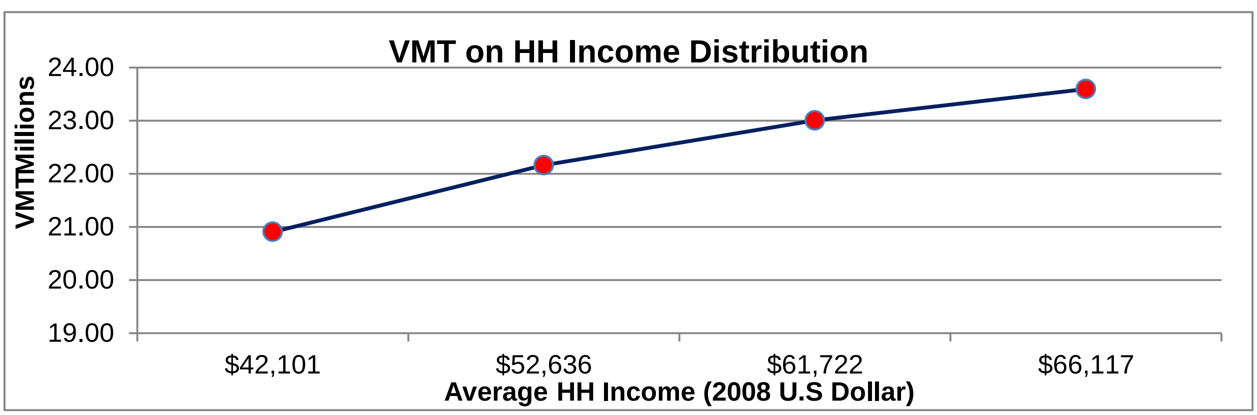


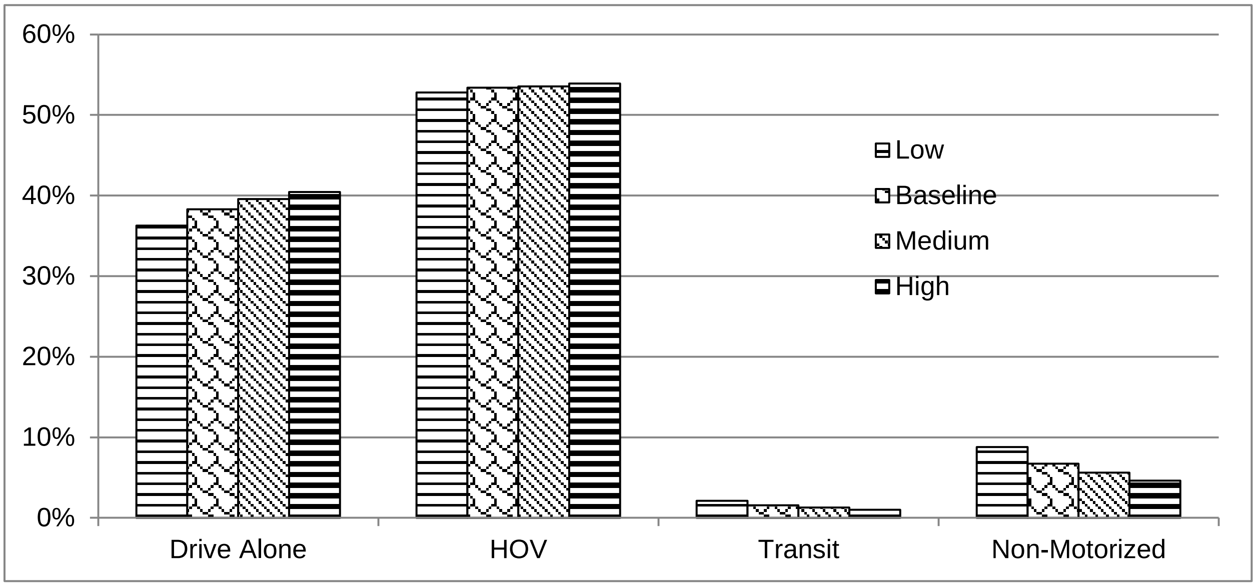
Figure 17: VMT Changes for Household Income Distribution Scenarios shows the model's responsiveness to household income changes. As expected, VMT increased as household income increased.

Figure 17: VMT Changes for Household Income Distribution Scenarios



The impact of household income on mode share was also examined. As shown in Figure 18 the mode share responded to household income distribution changes as expected. The drive alone share increased when household income increased while transit and non-motorized trips decreased.

Figure 18: Mode Share Response to Household Income Changes



E. SCS Performance Indicators

Performance Indicators provide qualitative evidence of GHG reductions.

ARB staff evaluated changes in key non-GHG indicators that describe SCS performance. These indicators are examined to determine if they can provide qualitative evidence that the SCS, if implemented, could meet its GHG targets. The evaluation looked at directional consistency of the indicators with Fresno COG's modeled GHG emissions reductions, as well as the general relationships between those indicators and GHG emissions reductions, based on the empirical literature. The SCS performance indicators evaluated include residential density, jobs-housing balance, mix of housing types, proximity of new jobs and housing to transit, farmland preservation, average auto trip length, per capita passenger VMT, and investment in active transportation. ARB staff assessment relies on key empirical studies for each indicator that illustrate qualitatively how changes in these indicators can increase or decrease VMT and/or GHG emissions.

1. Land Use Indicators

In order to determine the benefits of the development pattern in the SCS on GHG emissions from passenger vehicles, the evaluation focused on performance indicators related to land use: changes in residential density, jobs-housing balance, and mix of housing types.

a) *Residential Density*

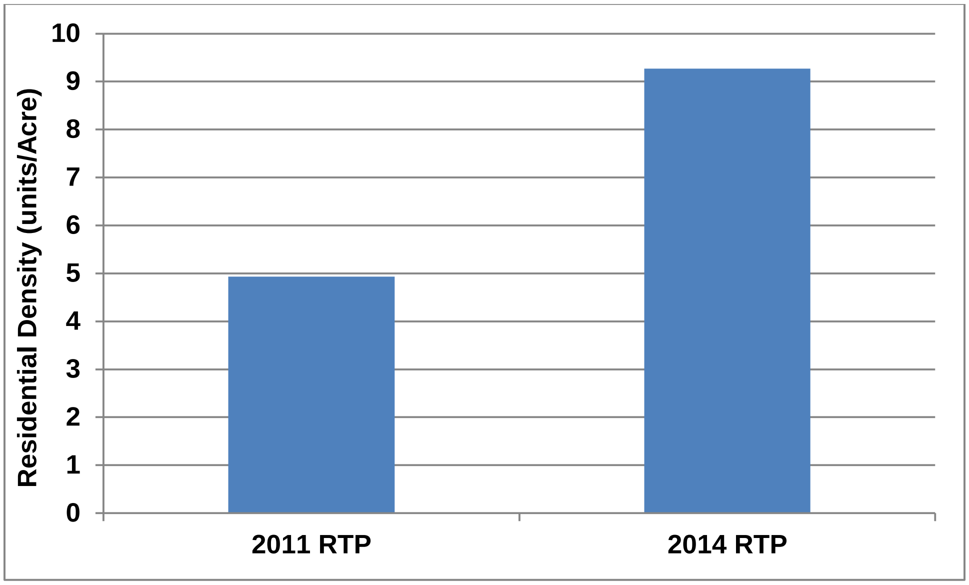
Residential density is a measure of the average number of dwelling units per acre of developed land. Travel characteristics in the region are expected to change as the housing market shifts from single unit homes on larger lots, to single unit homes on smaller lots, townhomes, and multifamily housing. Expected changes in travel behavior include reductions in average trip length, and eventually a decrease in regional VMT.

A review of relevant empirical literature reveals this is likely to be the case. Brownstone and Golob analyzed National Household Travel Survey (NHTS) data and observed that denser housing development significantly reduces annual vehicle mileage and fuel consumption, which directly results in the reduction in GHG emissions. They also reported that households in areas with 1,000 or more units per square mile drive 1,171 fewer miles and consume 64.7 fewer gallons of fuel than households in less dense areas. Boarnet and Handy (2010) reported that doubling residential density reduces VMT an average of 5 to 12 percent. Litman (2010) reported that increased population density leads to a 0.2 to 1.45 percent decrease in the demand for car travel.

Fresno COG's land use forecast in the 2014 RTP/SCS projects that between 2008 and 2035 the region's residential density will increase to 9.3 dwelling units per residential acre in new growth areas. Compared to its 2011 RTP, this residential density in new growth area almost doubled (Figure 19). This increase in residential density is consistent with the empirical literature which indicates the likelihood of reductions in household VMT and auto trip length, shifts in travel mode away from single occupant vehicles, and reductions in GHG emissions.

This increase in residential density is consistent with the empirical literature which indicates the likelihood of reductions in household VMT and auto trip length, shifts in travel mode away from single occupant vehicles, and reductions in GHG emissions.

Figure 19: Residential Density of New Development (2008-2035)



b) Jobs-Housing Balance

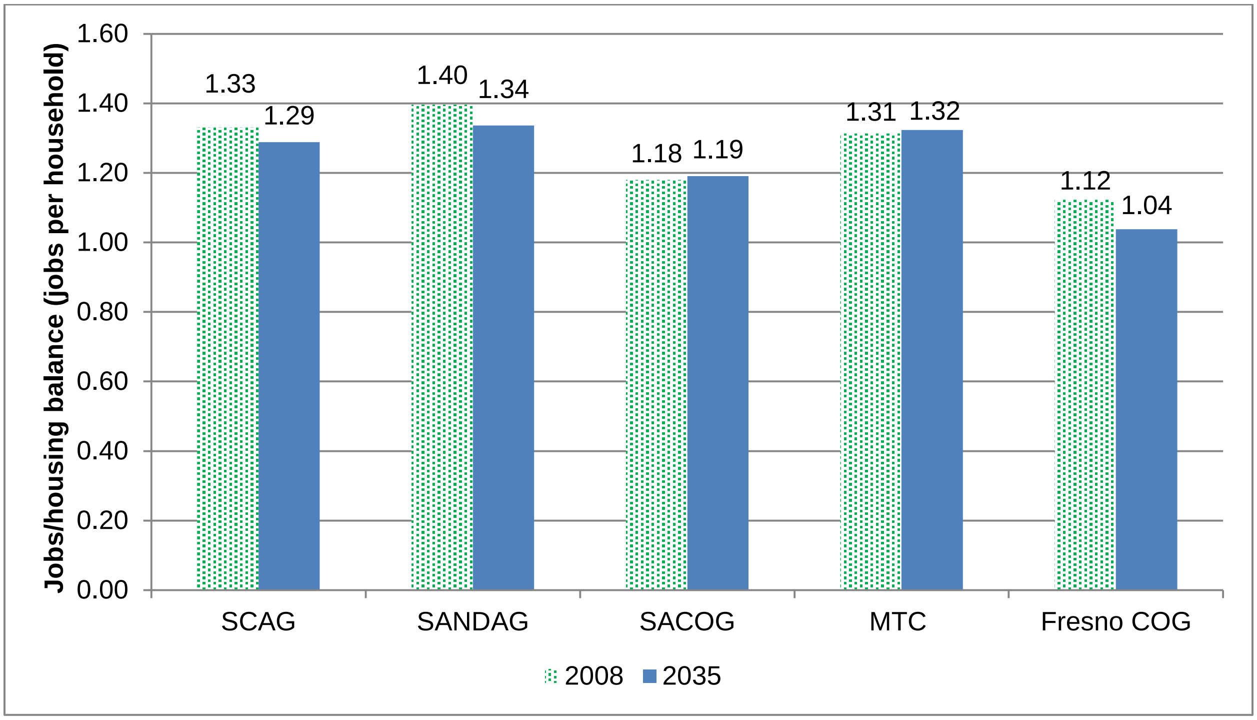
Jobs-Housing balance refers to the approximate distribution of employment opportunities and workforce population across a geographical area. It is usually measured in terms of the proportion of jobs per household. For example, a job/housing balance of 1.25 means there are 1.25 jobs per household. The aim of job/housing balance is to provide local employment opportunities that may reduce overall commuting distance among residents, and also the reverse – to provide homes near workplaces. The literature reports that a jobs/housing balance is sensitive to the area of analysis. In one study, an area defined as a “commute shed” is an area of about 14 miles in radius around an employment center, and a jobs/housing ratio between 1.0 and 1.3 is considered “balanced” (Armstrong, 2001[24]). Generally, a jobs/housing ratio closer to 1.3 is accepted as “balanced” considering that California’s households have an average of 1.3 workers (Kroll 2008[25]) Figure 20 summarizes the jobs/housing ratios of Fresno COG and major MPOs in California in 2008 and in 2035 estimated based on

[24] Boarnet., et. al. 2014

[25] Ibid.

their latest adopted SCS. Compared to other MPOs, job growth in Fresno COG is relatively slower, but this is a similar trend in the Valley. Due to lower job growth, it is expected that some residents in the region to would commute out of the county for more job opportunities.

Figure 20: Comparison of Jobs/Housing Ratio with Major MPOs[26]

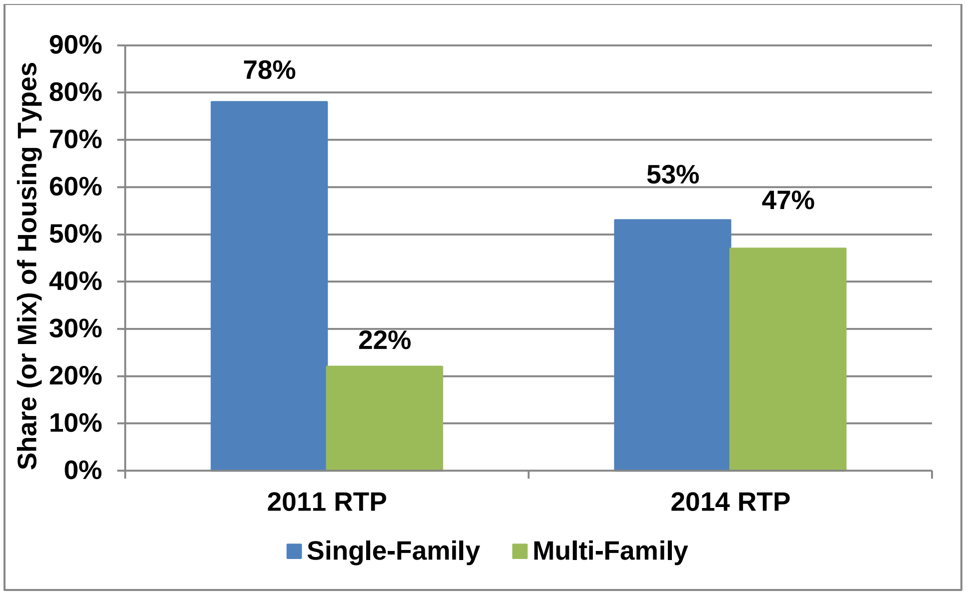


c) Mix of Housing Types

Fresno COG's 2014 RTP/SCS indicates a shift towards a greater percentage of new multi-family housing units. Figure 21 shows the percentage of new housing types anticipated by the 2011 RTP and the 2014 RTP. By 2035, the share of new multi-family housing units is forecasted to increase from 22 percent of the total new housing units (2011 RTP) to 47 percent (2014 RTP/SCS). The share of single-family units decreases from 78 percent of new units to 53 percent of new units by 2035.

[26] The total numbers of jobs and employment in 2008 in MTC were estimated by interpolation with 2005 and 2010 data.

Figure 21: Shift Towards Multi-Family Housing (2008 - 2035)



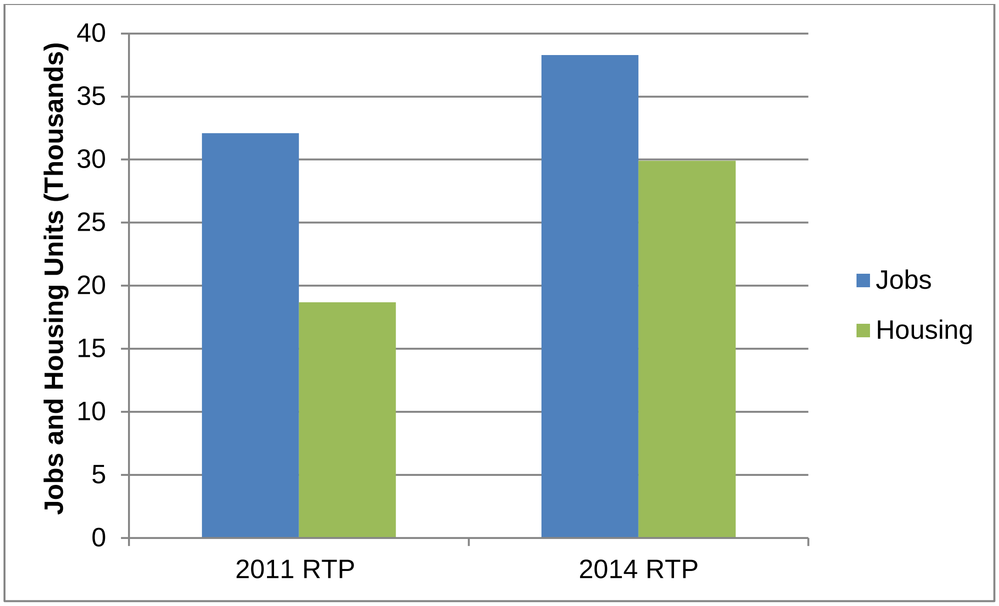
d) Jobs and Housing Near Transit

Proximity of housing and employment to transit is a commonly used performance indicator for evaluating the effectiveness of transit oriented development (TOD). The empirical literature indicates that focusing growth to areas with access to transit will encourage the use of transit, reducing vehicle trips and subsequently reducing passenger vehicle-related GHG emissions.

Studies show that proximity of housing and employment to transit stations is highly correlated with increased transit ridership as housing and employment increases within a one mile radius of transit stations (Kolko 2011). Other studies show significant VMT reductions for placement of housing and employment closer to rail stations and bus stops (Tal, et.al 2010).

Figure 22 summarizes the forecasted number of jobs and housing units near transit based on Fresno COG's 2011 RTP and the 2014 RTP. Compared to Fresno COG's 2011 RTP, its 2014 RTP/SCS shows an increase in the numbers of jobs and housing units within ½-mile of transit, between 2008 and 2035.

Figure 22: Jobs and Housing Near Transit (new growth from 2008-2035)

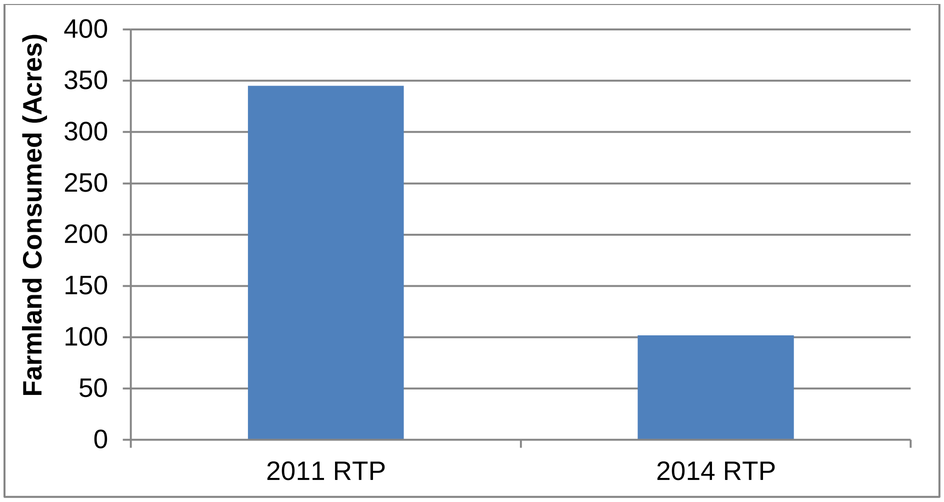


e) Farmland Preservation

The San Joaquin Valley is known as a major agriculture production area in the U.S. The RTP/SCS encourages development within existing communities to preserve farmland in the region. Table 3 earlier in the report outlined the total important farmland consumed by the 2011 RTP and the 2014 RTP/SCS. Figure 23 compares the forecasted consumption of farmland as defined in SB 375[27] and indicated in the 2011 RTP and the 2014 RTP/SCS. The 2014 RTP/SCS consumes significantly fewer acres of farmland by 2035 as compared to the 2011 RTP.

[27] Important farmland outside of existing spheres of influence.

Figure 23: Farmland Consumed by 2035



2. Transportation-Related Indicators

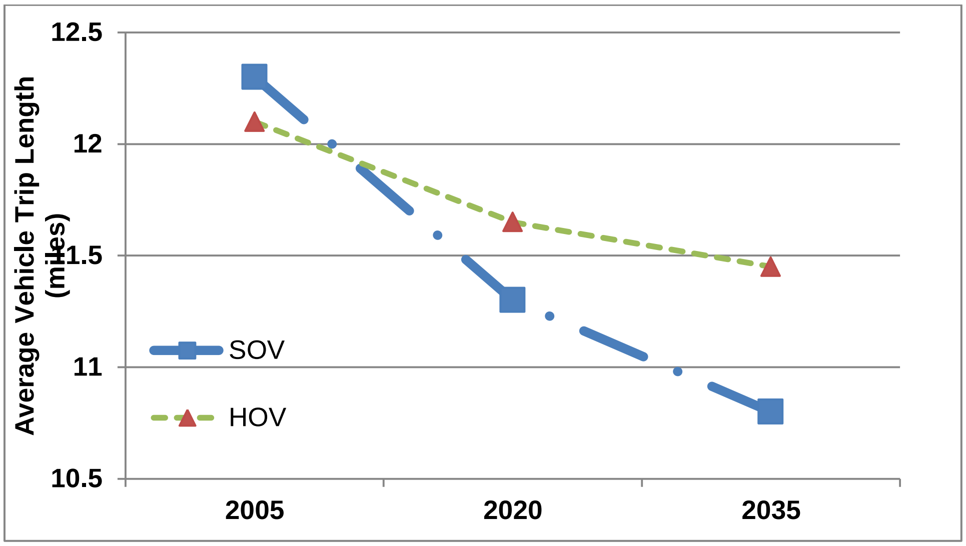
ARB staff evaluated five transportation performance indicators along with supporting data inputs, assumptions, and sensitivity analyses. These indicators are average vehicle trip length, passenger VMT, and transportation investment.

a) Average Auto Trip Length

A decrease in the average auto trip length can contribute to an overall reduction of GHG emissions in a region by decreasing overall miles traveled in a vehicle.

Figure 24 shows the average trip lengths by auto mode for all trip purposes in the Fresno COG region, as reported in its 2014 RTP/SCS. The data shows that the average trip length for SOV and HOV auto modes decreases consistently between 2005 and 2035. SOV trip length on average decreases from 12.3 miles in 2005 to 10.8 miles in 2035. HOV trip length on average decreases from 12.1 miles in 2005 to 11.45 miles in 2035. These trends support the GHG emissions reductions estimated for the Fresno COG region.

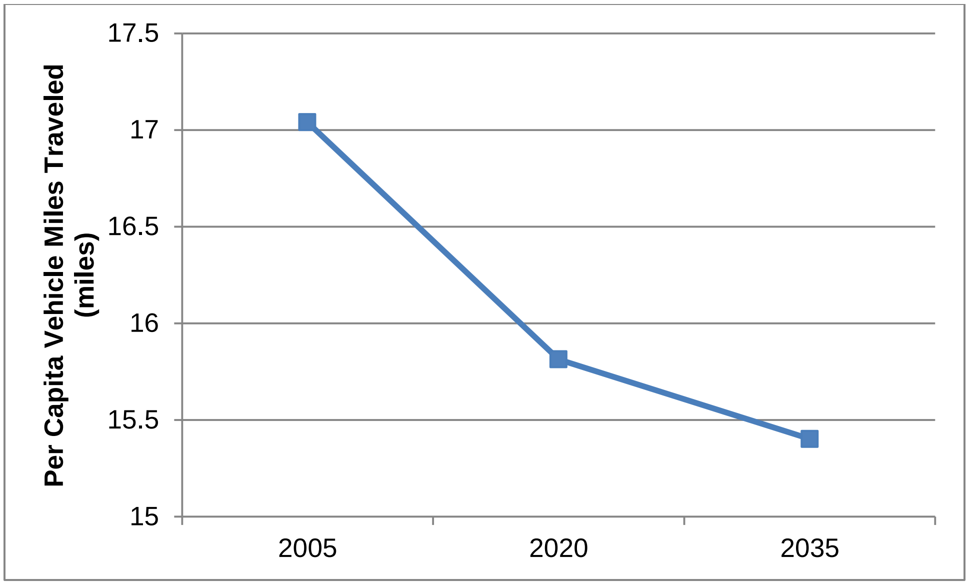
Figure 24: Average Auto Trip Length



b) Vehicle Miles Traveled

The Fresno COG 2014 RTP/SCS shows a decline in per capita passenger vehicle VMT between 2005 and 2035, which is show in Figure 25. Per capita VMT decreases by 7.2% and 9.6% between 2005 and 2020 and between 2005 and 2035, respectively. The quantification of GHG emissions from passenger vehicles is a function of VMT and vehicle speeds. These results are directionally consistent and support Fresno COG's reported GHG emissions reduction trend over time.

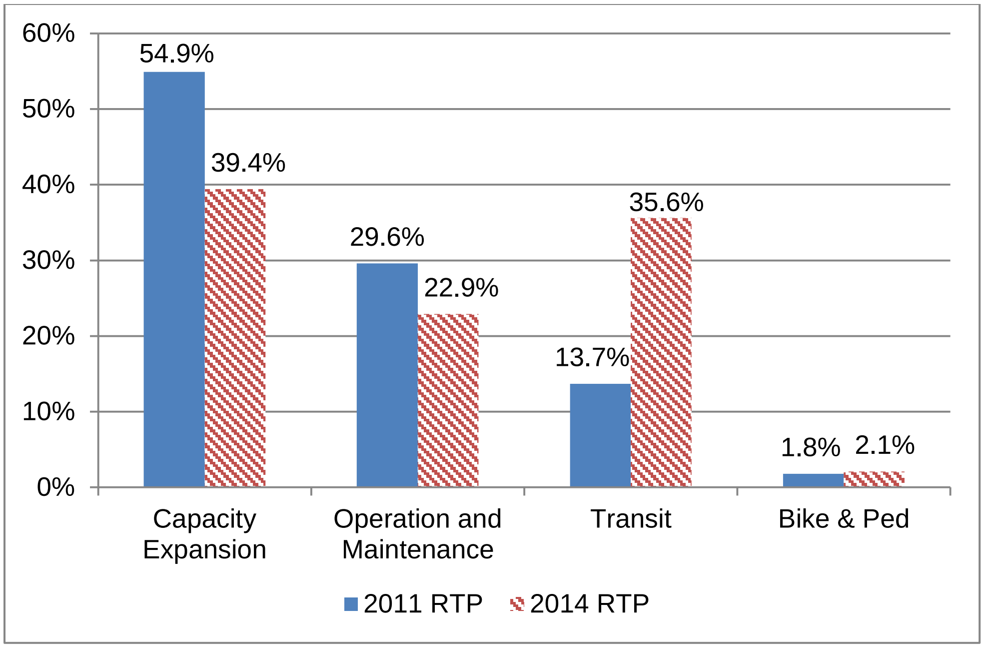
Figure 25: Per Capita Passenger VMT



c) Transportation Investment

The 2014 RTP/SCS reflects increased investment in bike and walk facilities and public transit as compared to the 2011 RTP (Figure 26). Investment in bike and pedestrian infrastructure increases from 1.8 percent of the total RTP budget to 2.1 percent of the total budget. Similarly, investment in transit increases from 13.7 percent of the total budget to 35.6 percent. The increase in investments in public transit and bike and walk facilities will provide greater opportunities for travelers to take advantage of these non-automobile modes of travel, thereby encouraging a shift away from single occupant vehicle use and with it, a reduction in GHG emissions.

Figure 26: Increased Investment in Transit and Bike/Walk Facilities

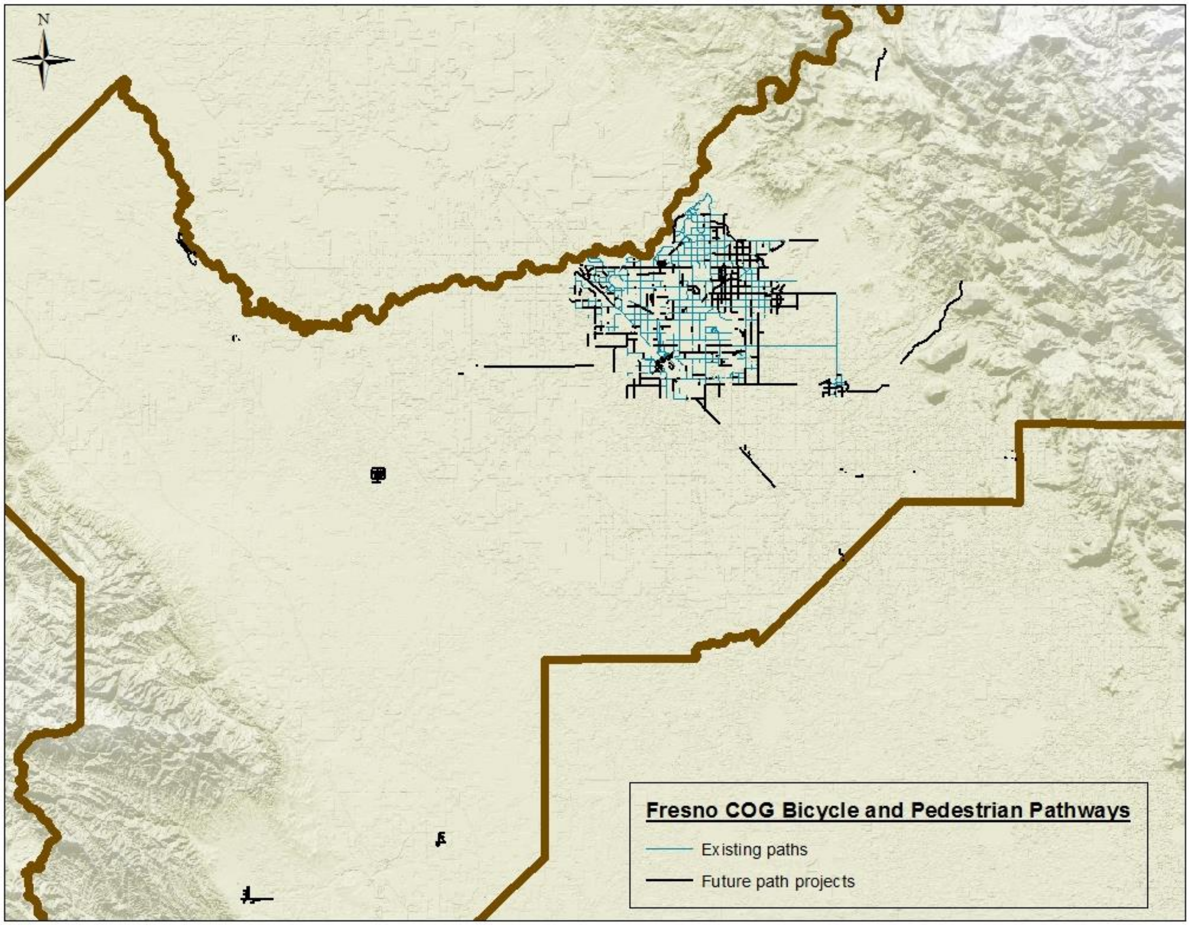


d) Active Transportation

Active transportation refers to a variety of modes of travel that are generally human powered, such as bicycling and walking. In most cases, when a person chooses to replace a car trip with a bike or walk trip to a destination, passenger VMT is reduced, along with GHG emissions. In reviews of the empirical literature related to the impacts of putting bicycling- and pedestrian-related strategies in place, Handy, Sciara, et.al. (2010, 2011) found that a variety of active transportation strategies have the potential to reduce vehicle trips and VMT. Increasing the number of miles of bikeways and sidewalks, making changes to existing bike/pedestrian infrastructure to improve the safety, security, or comfort of cyclists and pedestrians, or creating better bike/pedestrian links to transit stations are among the strategies that have been found to increase the likelihood of a shift in trips from cars to bicycles, walking, and/or transit.

Fresno COG’s 2014 RTP/SCS supports expansion of the existing network of bicycle and pedestrian facilities that can connect adjoining communities, provides better bike/walk access to transit facilities, maintains the existing bike/walk facilities, and creates a safer and more secure active transportation system. Figure 27 illustrates the existing and proposed bike networking in the Fresno COG region. Many of the bike and walk facility related projects in the RTP/SCS are proposed in the downtown areas of existing communities.

Figure 27: Existing and Proposed Bike Network in Fresno COG's 2014 RTP



IV. Conclusion

This report documents ARB staff's technical evaluation of the Fresno COG's adopted RTP/SCS. This evaluation affirms that Fresno COG's adopted 2014 SCS would, if implemented, meet the Board adopted per capita GHG emissions reduction targets of five percent reduction in 2020 and 10 percent reduction in 2035.

V. References

Boarnet, Marlon G., and Susan Handy. 2014. “Impacts of Residential Density on Passenger Vehicle Use and Greenhouse Gas Emissions, Policy Brief.” 30 September 2014. Web. Accessed 2014. http://arb.ca.gov/cc/sb375/policies/policies.htm

California Air Resources Board. 2011. Description of Methodology for ARB Staff Review of Greenhouse Gas Reductions from Sustainable Communities Strategies (SCS) Pursuant to SB 375. July 2011. http://www.arb.ca.gov/cc/sb375/scs_review_methodology.pdf

California Transportation Commission. 2010. Regional Transportation Plan Guidelines and National Cooperative Highway Research Program (NCHRP) Report 365.

Circella, G., Handy, S., Boarnet, M. 2014. Impacts of Gas Price on Passenger Vehicle Use and Greenhouse Gas Emissions. 30 September 2014. http://arb.ca.gov/cc/sb375/policies/policies.htm

County of Fresno. 2013. Regional Bicycle & Recreational Trails Master Plan. Accessed 21 November 2014. http://www.co.fresno.ca.us/ViewDocument.aspx?id=50346

FCOG. See *Fresno Council of Governments.*

Federal Highway Administration. 2010. Travel Model Validation and Reasonableness Checking Manual Second Edition. Accessed August 2014 from https://www.fhwa.dot.gov/planning/tmip/publications/other_reports/validation_and_reasonableness_2010/

Fehr & Peers. 2014. Model Description & Validation Report: Fresno Council of Governments Travel Demand Model 2008 Base. January 2014. http://www.fresnocog.org/sites/default/files/publications/Modeling/MIPModel_Documentation.pdf

Fresno Council of Governments. 2014a. 2014 Regional Transportation Plan and Sustainable Communities Strategy. Accessed 20 September 2014. http://www.fresnocog.org/rtp.

Fresno Council of Governments. 2014b. Off-model Calculations. Email submittal to ARB by Fresno COG on 9 December 2014.

Fresno Council of Governments. 2014c. GIS Map Layers. Email submittal to ARB by Fresno COG on 9 December 2014.

Fresno Council of Governments. 2014d. May 29, 2014 Policy Board Meeting Agenda, Item II A. Accessed 15 October 2014. http://agendas.fresnocog.org/agenda/read/206

Fresno Council of Governments. 2014e. MPO Transportation Investment Spreadsheet. Email submittal to ARB by Fresno COG on 9 May 2014.

Fresno Council of Governments. 2014f. Resolution Adopting the Fresno Council of Governments 2015 Federal Transportation Improvement Program, the 2014 Regional Transportation Plan/ Sustainable Community Strategy, and the Corresponding Conformity Analysis. 26 June 2014. Accessed 9 December 2014. http://www.fresnocog.org/sites/default/files/publications/RTP/resolution_2014-10.pdf

Fresno Council of Governments. 2012. Sustainable Communities Strategy Technical Methodology. Accessed 15 October 2014. http://www.arb.ca.gov/cc/sb375/mpo/cofcg/fresno_tech_meth091112.pdf.

Fresno Council of Governments. 2008. Bus Rapid Transit Master Plan. Accessed 20 October 2014. http://www.fresno.gov/NR/rdonlyres/46E037A5-7C80-4A5A-935D-DCE67B77A230/0/FresnoBRTMasterPlan20080617.pdf

Handy, S., Sciara, G., Boarnet, M. 2014. Impacts of Pedestrian Strategies on Passenger Vehicle Use and Greenhouse Gas Emissions. 30 September 2014.

Handy, S., Lovejoy, K., Boarnet, M., Spears, S. 2013. “Policy Brief on the Impacts of Transit Service Strategies Based on a Review of the Empirical Literature.” 8 October 2013. Web. Accessed 2014. http://arb.ca.gov/cc/sb375/policies/policies.htm

San Joaquin Valley Councils of Governments. 2010. San Joaquin Valley Blueprint Roadmap. Accessed 20 October 2014. http://www.sjvcogs.org/pdfs/2012/RoadMap012512.pdf

SJVCOG see *San Joaquin Valley Councils of Governments*

VRPA Technologies, Inc. 2014. 2014 Regional Transportation Plan and Sustainable Communities Strategy Final Program Environmental Impact Report. Prepared for Fresno Council of Governments. June 3, 2014.

APPENDIX A. Fresno COG's Modeling Data Table

This appendix contains Fresno COG's responses, received on December 15, 2014, to data requests from ARB staff to supplement ARB staff's evaluation of Fresno COG's quantification of GHG emissions. ARB requested this data in accordance with the general approach described in ARB's July 2011 evaluation methodology document. (N/A means not available in this table.)

Modeling Parameters	2005	2008	2020		2035		2040		Data Source(s)
	If available	Base Year	With Project[1]	Without Project[2]	With Project	Without Project	With Project	Without Project	
DEMOGRAPHICS									
Total population	871,910	912,521	1,082,097	1,082,097	1,300,597	1,300,597	1,373,697	1,373,697	The Planning Center
Group quarters population	17,827	18,249	22,864	22,864	28,187	28,187	29,971	29,971	" "
Total employment (employees)	335,159	345,816	363,581	363,581	427,728	427,728	449,111	449,111	" "
Average unemploymen t rate (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Total number of households	286,499	308,047	350,337	345,500	412,180	400,091	433,333	418,749	Land Use Model
Persons per household	2.98	2.90	3.02	3.07	3.09	3.18	3.10	3.21	Calculated
Auto ownership per household	1.74	1.74	1.74	1.76	1.74	1.78	1.74	1.78	MIP model
Median household income	$41,899	$43,737	N/A	N/A	N/A	N/A	N/A	N/A	American Community Surveys
LAND USE[4]									
Total acres within MPO	3,847,339	3,847,339	3,847,339	3,847,339	3,847,339	3,847,339	3,847,339	3,847,339	GIS

Modeling Parameters	2005	2008	2020		2035		2040		Data Source(s)
	If available	Base Year	With Project	Without Project	With Project	Without Project	With Project	Without Project	
Total resource area acres (CA GC Section 65080.01)	3,328,690	3,328,690	3,328,690	3,328,690	3,328,690	3,328,690	3,328,690	3,328,690	FMMP 2010, FEMA floodzones, Critical Habitat Areas, General Plan data,
Total farmland acres (CA GC Section 65080.01)	N/A	1,157,570	N/A	N/A	1,157,468	1,157,225	N/A	N/A	FMMP 2010, City Spheres of Influence
Total developed acres	160,271	165,819	170,909	172,881	180,494	188,127	184,049	193,907	SCS data
Total commercial developed acres	N/A	64,680	N/A	N/A	68,321	68,695	N/A	N/A	" "
Total residential developed acres	N/A	101,139	N/A	N/A	112,173	119,432	N/A	N/A	" "
Total housing units	305,093	327,885	373,494	368,338	439,425	426,537	461,976	446,428	Calculated
Housing vacancy rate	6.49%	6.44%	6.61%	6.61%	6.61%	6.61%	6.61%	6.61%	The Planning Center
Total single-family detached households	191,331	205,725	228,366	234,595	261,392	277,632	272,811	292,511	SCS data

Modeling Parameters	2005	2008	2020		2035		2040		Data Source(s)
	If available	Base Year	With Project	Without Project	With Project	Without Project	With Project	Without Project	
Total small-lot single family detached households (4,000 sq. ft. lots and smaller)	25,524	27,444	39,378	37,344	57,663	52,104	64,032	57,131	" "
Total conventional-lot single family detached households (between 4,000 and 10,000 sq. ft. lots)	110,838	119,177	125,750	129,670	135,195	145,574	138,446	151,086	" "
Total large-lot single family detached households (10,000 sq ft. lots and larger)	54,970	59,105	63,238	67,580	68,534	79,954	70,333	84,294	" "
Total single-family attached households	9,925	10,671	13,113	12,367	16,561	14,758	17,738	12,367	" "
Total multi-family households	72,227	77656	94,863	84,543	120,232	93,706	128,789	99,876	" "

Modeling Parameters	2005	2008	2020		2035		2040		Data Source(s)
	If available	Base Year	With Project	Without Project	With Project	Without Project	With Project	Without Project	
Total mobile homes & other	*13,016*	*13,995*	*13,995*	*13,995*	*13,995*	*13,995*	*13,995*	*13,995*	" "
Total infill households	241,197	258,564	283,204	277,901	311,810	300,475	320,881	307,599	Infill = within existing city limits and county islands
Total Single Family (for ARB summary)	191,331	205,725	228,366	234,595	261,392	277,632	272,811	292,511	Calculated: Single Family Detached housing units only
Total Multi-family (for ARB summary)	95,168	102,322	121,971	110,905	150,788	122,459	160,522	126,238	Calculated: Single Family attached + all other categories
Total mixed use households	0	0	7,515	6,218	16,362	14,051	19,119	16,553	SCS data
Total housing units within 1/4 mile of transit stations and stops	79500	85200	96200	91900	107,600	97,900	111100	99600	SCS data (estimated)
Total housing units within 1/2 mile of transit stations and stops	102100	109400	123800	119200	139,300	128,100	143600	131200	" "

Modeling Parameters	2005	2008	2020		2035		2040		Data Source(s)
	If available	Base Year	With Project	Without Project	With Project	Without Project	With Project	Without Project	
Total employment within 1/4 mile of transit stations and stops	139,100	143,500	151,000	148,500	176,800	168,500	188,100	172,500	" "
Total employment within 1/2 mile of transit stations and stops	162,000	167,100	175,900	173,500	205,400	199,200	218,800	204,200	" "
TRANSPORTATION SYSTEM									
Freeway general purpose lanes – mixed flow lane miles	650.45	662.6	691.36	691.36	697.29	697.29	697.29	697.29	MIP model
Highway (lane miles)	691.97	691.97	785.6	785.6	856.28	856.28	856.28	856.28	" "
Expressway (lane miles)	616.53	643.58	701.16	701.16	788.34	788.34	788.34	788.34	" "
HOV (lane miles)	0	0	0	0	0	0	0	0	" "
Arterial (lane miles)	2148.57	2157.6	2218.14	2218.14	2304.54	2304.54	2304.54	2304.54	" "
Collector (lane miles)	2191.49	2202.04	2227.3	2227.3	2281.91	2281.91	2281.91	2281.91	" "
Local (lane miles)	11.4	11.4	10.98	10.98	10.98	10.98	10.98	10.98	" "

Modeling Parameters	2005	2008	2020		2035		2040		Data Source(s)
	If available	Base Year	With Project	Without Project	With Project	Without Project	With Project	Without Project	
Freeway-Freeway (lane miles)	20.19	20.19	26.35	26.35	26.35	26.35	26.35	26.35	" "
Local, express bus, and neighborhood shuttle operation miles	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Bus rapid transit bus operation miles	0	0	32	32	84	32	84	32	MIP model
Passenger rail operation miles	0	0	0	0	0	0	0	0	" "
Transit total daily vehicle service hours	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Bicycle and pedestrian trail/lane miles	N/A	74	N/A	N/A	N/A	N/A	N/A	N/A	Class I trails, assuming 1 lane per dir
Vanpool (total riders per weekday)	N/A	1,835	N/A	N/A	N/A	N/A	N/A	N/A	CalVans Report [2012 Daily Trips]/2
TRIP DATA[5]									
Number of trips by trip purpose									
Home-based work	350,331	387,246	440,219	445,507	523,476	536,540	551,366	566,560	MIP model, II only
Home-based other	1,148,585	1,236,961	1,433,460	1,445,423	1,694,825	1,722,597	1,781,326	1,813,782	" "

Modeling Parameters	2005	2008	2020		2035		2040		Data Source(s)
	If available	Base Year	With Project	Without Project	With Project	Without Project	With Project	Without Project	
Non-home-based work	95,026	102,813	107,140	105,213	136,971	131,805	146,906	140,141	" "
Non-home-based other	388,487	408,680	450,587	450,240	551,776	545,781	584,763	576,299	" "
Vehicle Trips by trip purpose									
Home-Work	352,250	381,114	433,841	430,177	507,807	519,501	532,744	546,369	MIP post processing, including II, IX, XI, and XX
Home-Shop	181,520	195,206	226,851	228,656	268,119	272,672	281,892	287,159	" "
Home-Other	589,004	632,131	733,535	739,716	866,317	880,418	910,305	926,830	" "
Work-Other	86,280	92,624	96,054	94,238	121,603	117,101	130,107	124,219	" "
Other-Other	268,770	282,635	311,259	310,998	381,032	376,895	403,762	397,922	" "
MODE SHARE									
Vehicle Mode Share (for HBW trips)									
SOV (% of trips)	82.3%	82.1%	82.0%	82.3%	81.9%	82.2%	81.9%	82.3%	MIP model, II only
HOV (% of trips)	13.1%	13.3%	13.4%	13.3%	13.4%	13.5%	13.4%	13.5%	" "
Transit (% of trips)	1.4%	1.3%	1.4%	1.3%	1.5%	1.2%	1.5%	1.2%	" "
Non-motorized (% of trips)	3.1%	3.2%	3.3%	3.1%	3.2%	3.1%	3.2%	3.1%	" "

Modeling Parameters	2005	2008	2020		2035		2040		Data Source(s)
	If available	Base Year	With Project	Without Project	With Project	Without Project	With Project	Without Project	
Vehicle Mode Share (Whole Day)									
SOV (% of trips)	38.8%	38.5%	38.2%	38.4%	38.0%	38.4%	38.0%	38.4%	MIP model, II only
HOV (% of trips)	53.0%	53.2%	53.4%	53.6%	53.5%	53.9%	53.5%	53.9%	" "
Transit (% of trips)	1.6%	1.5%	1.6%	1.5%	1.6%	1.4%	1.6%	1.3%	" "
Non-motorized (% of trips)	6.6%	6.7%	6.8%	6.5%	6.8%	6.4%	6.9%	6.3%	" "
Average weekday trip length (miles)									
Drive Alone	12.3	11.1	11.3	10.9	10.8	10.9	10.7	10.8	MIP post processing, including II, IX, XI, and XX
Shared-ride 2	12.3	11.7	11.8	11.7	11.6	11.8	11.5	11.7	" "
Shared-ride 3+	11.9	11.3	11.5	11.4	11.3	11.5	11.2	11.4	" "
Transit	4.9	4.7	4.8	4.9	4.9	4.9	4.9	4.9	" "
Walk/Bike	3.2	3.3	3.2	3.3	3.2	3.3	3.2	3.3	" "
Average weekday travel time (minutes)									
Drive Alone	18.7	17.5	17.7	17.4	17.7	17.9	17.7	18.0	MIP post processing (II, IX, XI, and XX)

Modeling Parameters	2005	2008	2020		2035		2040		Data Source(s)
	If available	Base Year	With Project	Without Project	With Project	Without Project	With Project	Without Project	
Shared-ride 2	18.6	18.3	18.3	18.3	18.4	18.7	18.5	18.8	" "
Shared-ride 3+	18.2	18.0	18.0	18.0	18.1	18.4	18.2	18.5	" "
Transit	9.6	9.7	9.8	9.8	10.0	10.0	10.1	10.1	" "
Walk/Bike	7.5	7.7	7.6	7.6	7.6	7.7	7.7	7.8	" "
TRAVEL MEASURES									
Total VMT per weekday for ALL vehicles excluding XX (miles)	17,942,017	N/A	20,294,603	20,663,221	23,766,798	24,485,124	24,873,544	25,661,982	MIP model, excluding XX
Total VMT per weekday for passenger vehicles (ARB vehicle classes of LDA, LDT1, LDT2 and MDV) (miles)	17,685,520	N/A	21,612,529	21,676,830	25,809,961	26,373,648	27,129,427	27,765,214	EMFAC2011
Total II (Internal) VMT per weekday for passenger vehicles (miles)	13,311,025	N/A	15,484,476	15,530,545	18,286,318	18,685,690	19,173,923	19,623,271	MIP model (adjusted to EMFAC total)

Modeling Parameters	2005	2008	2020		2035		2040		Data Source(s)
	If available	Base Year	With Project	Without Project	With Project	Without Project	With Project	Without Project	
Total IX/XI VMT per weekday for passenger vehicles (miles)	1,557,458	N/A	1,627,550	1,632,392	1,746,171	1,784,307	1,789,432	1,831,368	" "
Total XX VMT per weekday for passenger vehicles (miles)	2,817,038	N/A	4,500,503	4,513,893	5,777,472	5,903,651	6,166,072	6,310,575	" "
Congested DAILY VMT on freeways (Lane Miles, V/C ratios >0.75)	2,509,091	2,645,224	2,972,056	2,947,898	3,762,593	3,941,204	4,194,802	4,582,360	MIP model
Congested DAILY VMT on all other roadways (Lane Miles, V/C ratios >0.75)	669,743	1,978,126	1,423,580	1,420,735	2,804,821	2,916,591	3,320,100	3,378,370	" "

Modeling Parameters	2005	2008	2020		2035		2040		Data Source(s)
	If available	Base Year	With Project	Without Project	With Project	Without Project	With Project	Without Project	
CO2 EMISSIONS[3]									
Total CO2 emissions per weekday for passenger vehicles (ARB vehicle classes LDA, LDT1, LDT2, and MDV) (tons)	8,299	N/A	10,074	10,109	12,061	12,307	12,730	13,000	EMFAC2011
Total II (Internal) CO2 emissions per weekday for passenger vehicles(tons)	6,246	N/A	7,217	7,242	8,545	8,720	8,997	9,188	EMFAC2011 (estimated based on VMT)
Total IX / XI trip CO2 emissions per weekday for passenger vehicles (tons)	731	N/A	759	761	816	833	840	857	" "
Total XX trip CO2 emissions per weekday for passenger vehicles (tons)	1,322	N/A	2,098	2,105	2,700	2,755	2,893	2,955	" "

Modeling Parameters	2005	2008	2020	2035		2040			Data Source(s)
	If available	Base Year	With Project	Without Project	With Project	Without Project	With Project	Without Project	
INVESTMENT (Billions)									
Total RTP Expenditure (Year 2040 $)	N/A	N/A	N/A	N/A	N/A	N/A	$4,463,929,000	N/A	
Highway capacity expansion ($)	N/A	N/A	N/A	N/A	N/A	N/A	$1,756,245,000	N/A	
Other road capacity expansion ($)	N/A	N/A	N/A	N/A	N/A	N/A		N/A	
Roadway maintenance ($)	N/A	N/A	N/A	N/A	N/A	N/A	$1,023,948,000	N/A	
BRT projects ($)	N/A	N/A	N/A	N/A	N/A	N/A		N/A	
Transit capacity expansion ($)	N/A	N/A	N/A	N/A	N/A	N/A	$1,591,878,000	N/A	
Transit operations ($)	N/A	N/A	N/A	N/A	N/A	N/A		N/A	
Bike and pedestrian projects ($)	N/A	N/A	N/A	N/A	N/A	N/A	$91,858,000	N/A	
TRANSPORTATION USER COSTS									
Vehicle operating costs (Year 2009 $ per mile)	2000 $0.155	2000 $0.216	2000 $0.223	2000 $0.223	2000 $0.243	2000 $0.243	2000 $0.249	2000 $0.249	MIP model

Modeling Parameters	2005	2008	2020		2035		2040		Data Source(s)
	If available	Base Year	With Project	Without Project	With Project	Without Project	With Project	Without Project	
Gasoline price (Year 2009 $ per gallon)	2009 $2.67	2009 $4.00	2009 $4.74	2009 $4.74	2009 $5.24	2009 $5.24	N/A	N/A	Tabulated CA MPO Auto Ops Cost Spreadsheet (Updated)
Average transit fare (Year XXXX $)	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	MIP model
Parking cost (Year XXXX $)	2008 $3.00/$0.70	2008 $3.00/$0.70	2008 $3.00/$0.70	2008 $3.00/$0.70	2008 $3.00/$0.70	2008 $3.00/$0.70	2008 $3.00/$0.70	2008 $3.00/$0.70	MIP model, $3 for downtown Fresno, $0.7 for college campuses

1. This scenario includes modeling of all planned and programmed projects in RTP/SCS for respective calendar year.
2. This scenario should reflect the MPO's Business as Usual scenario, which for most is what would happen under the MPO's previously adopted RTP for the respective calendar year.
3. EMFAC Input and Output files associated with these outputs were provided to ARB by Fresno COG.

APPENDIX B. 2010 CTC RTP Guidelines Addressed in Fresno COG's RTP/SCS

This appendix lists the requirements in the California Transportation Commission's (CTC) Regional Transportation Planning (RTP) Guidelines that are applicable to the Fresno COG regional travel demand model, and which Fresno COG followed. In addition, listed below are the recommended practices from the CTC RTP Guidelines that Fresno COG incorporated into its modeling system.

Required

- Each MPO shall model a range of alternative scenarios in the RTP Environmental Impact Report based on the policy goals of the MPO and input from the public.
- MPO models shall be capable of estimating future transportation demand at least 20 years into the future. (Title 23 CFR Part 450.322(a))
- For federal conformity purposes, each MPO shall model criteria pollutants from on-road vehicles as applicable. Emission projections shall be performed using modeling software approved by the EPA. (Title 40 CFR Part 93.111(a))
- Each MPO shall quantify the reduction in greenhouse gas emissions projected to be achieved by the SCS. (California Government Code Section 65080(b)(2)(G))
- The MPO, the state(s), and the public transportation operator(s) shall validate data utilized in preparing other existing modal plans for providing input to the regional transportation plan. In updating the RTP, the MPO shall base the update on the latest available estimates and assumptions for population, land use, travel, employment, congestion, and economic activity. The MPO shall approve RTP contents and supporting analyses produced by a transportation plan update. (Title 23 CFR Part 450.322(e))
- The metropolitan transportation plan shall include the projected transportation demand of persons and goods in the metropolitan planning area over the period of the transportation plan. (Title 23 CFR Part 450.322(f)(1))
- The region shall achieve the requirements of the Transportation Conformity Regulations of Title 40 CFR Part 93.
- Network-based travel models shall be validated against observed counts (peak- and off-peak, if possible) for a base year that is not more than 10 years prior to the date of the conformity determination. Model forecasts shall be analyzed for reasonableness and compared to historical trends and other factors, and the results shall be documented. (Title 40 CFR Part 93.122 (b)(1)(i))
- Land use, population, employment, and other network-based travel model assumptions shall be documented and based on the best available information. (Title 40 CFR Part 93.122 (b)(1)(ii))
- Scenarios of land development and use shall be consistent with the future transportation system alternatives for which emissions are being estimated. The distribution of employment and residences for different transportation options shall be reasonable. (Title 40 CFR Part 93.122(b)(1)(iii))
- A capacity-sensitivity assignment methodology shall be used, and emissions estimates shall be based on methodology which differentiates between peak- and off-peak link volumes and speeds and uses speeds based on final assigned volumes. (Title 40 CFR Part 93.122 (b)(1)(iv))

- Zone-to-zone travel impedance used to distribute trips between origin and destination pairs shall be in reasonable agreement with the travel times that are estimated from final assigned traffic volumes. (Title 40 CFR Part 93.122(b)(1)(v))
- Network-based travel models shall be reasonably sensitive to changes in the time(s), cost(s), and other factors affecting travel choices. (Title 40 CFR Part 93.122 (b)(1)(vi))
- Reasonable methods in accordance with good practice shall be used to estimate traffic speeds and delays in a manner that is sensitive to the estimated volume of travel on each roadway segment represented in the network-based travel model. (Title 40 CFR Part 93.122(b)(2))
- Highway Performance Monitoring System (HPMS) estimates of vehicle miles travel (VMT) shall be considered the primary measure of VMT within the portion of the nonattainment or maintenance area and for the functional classes of urban area basis. For areas with network-based travel models, a factor (or factors) may be developed to reconcile and calibrate the network-based travel model estimates of VMT in the base year of its validation to the HPMS estimates for the same period. These factors may then be applied to model estimates of future VMT. In this factoring process, consideration will be given to differences between HPMS and network-based travel models, such as differences in the facility coverage of the HPMS and the modeled network description. Locally developed count-based programs and other departures from these procedures are permitted subject to the interagency consultation procedures of Section 93.105(c)(1)(i). (Title 40 CFR Part 93.122(b)(3))

Recommended

- The models should account for the effects of land use characteristics on travel, either by incorporating effects into the model process or by post-processing.
- During the development period of more sophisticated/detailed models, there may be a need to augment current models with other methods to achieve reasonable levels of sensitivity. Post-processing should be applied to adjust model outputs where the models lack capability, or are insensitive to a particular policy or factor. The most commonly referred to post-processor is a “D’s” post-processor, but post-processors could be developed for other non-D factors and policies, too.
- The models should address changes in regional demographic patterns.
- Geographic Information System (GIS) capabilities should be developed in these counties, leading to simple land use models in a few years.
- All natural resources data should be entered into the GIS.
- Parcel data should be developed within a few years and an existing land use data layer created.
- For the current RTP cycle (post last adoption), MPOs should use their current travel demand model for federal conformity purposes, and a suite of analytical tools, including but not limited to, travel demand models (as described in Categories B through E), small area modeling tools, and other generally accepted analytical methods for determining the emissions, VMT, and other performance factor impacts of sustainable communities strategies being considered pursuant to SB 375.

- Measures of means of travel should include percentage share of all trips (work and non-work) made by all single occupant vehicle, multiple occupant vehicle, or carpool, transit, walking, and bicycling.
- To the extent practical, travel demand models should be calibrated using the most recent observed data including household travel diaries, traffic counts, gas receipts, Highway Performance Monitoring System (HPMS), transit surveys, and passenger counts.
- It is recommended that transportation agencies have an on-going model improvement program to focus on increasing model accuracy and policy sensitivity. This includes on-going data development and acquisition programs to support model calibration and validation activities.
- When the transit mode is modeled, speed and frequency, days, and hours of operation of service should be included as model inputs.
- When the transit mode is modeled, the entire transit network within the region should be represented.
- Agencies are encouraged to participate in the California Inter-Agency Modeling Forum. This venue provides an excellent opportunity to share ideas and help to ensure agencies are informed of current modeling trends and requirements.
- MPOs should work closely with state and federal agencies to secure additional funds to research and implement the new land use and activity-based modeling methodologies. Additional research and development is required to bring these new modeling approaches into mainstream modeling practice.
- These regions should develop 4-step travel models as soon as is possible. In the near-term, post-processing should be used.
- The travel model set should be run to a reasonable convergence towards equilibrium across all model steps.
- Simple land use models should be used, such as GIS rule-based ones, in the short term.
- Parcel data and an existing urban layer should be developed as soon as is possible.
- A digital general plan layer should be developed in the short-term.
- A simple freight model should be developed and used.
- Several employment types should be used, along with several trip purposes.
- The models should have sufficient temporal resolution to adequately model peak and off-peak periods.
- Agencies should, at a minimum, have four-step models with full feedback across travel model steps and some sort of land use modeling.
- In addition to the conformity requirements, these regions should also add an auto ownership step and make this step and the mode choice equations for transit, walking and bicycling and the trip generation step sensitive to land use variables and transit accessibility.
- Walk and bike modes should be explicitly represented.
- The carpool mode should be included, along with access-to-transit sub modes.
- Feedback loops should be used and take into account the effects of corridor capacity, congestion and bottlenecks on mode choice, induced demand, induced growth, travel speed and emissions.

- Freight models should be implemented in the short term and commodity flows models within a few years.
- Simple Environmental Justice analyses should be done using travel costs or mode choice log sums, as in Group C. Examples of such analyses include the effects of transportation and development scenarios on low-income or transit-dependent households, the combined housing/transportation cost burden on these households, and the jobs/housing fit.